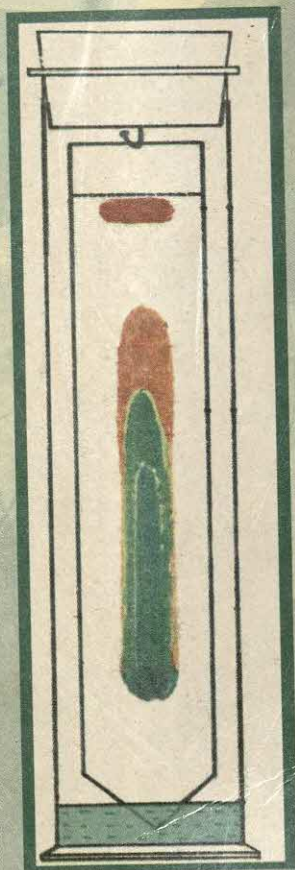


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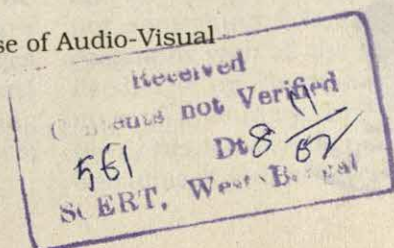
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An Urgent Need for Inclusion of GIS in the Curriculum of Geography and Computer Science

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In our country some of the latest developments in technologies in many of the educational fields are not incorporated at the right time. Sometimes they are not recognised as simple initial stages. But, if seen deeply, it will be revealed that they are very fundamental in the context of growing computer education and their applications. In the present day situation, many subject areas at the stages of elementary education lack proper emphasis on important applications desired. These applications will not only make that subject more interesting to the students but also attract many talents in that area. We would see that same contents are actually being taught in different stages at the school level in the present curriculum. Perhaps the one being suggested here exists but not in a form desired in the present day situation.

The application of GIS — Geographical Information System technologies in the curriculum of Geography at the school level. Though it may initially sound to be something from a higher platform, but with the changing character of education this would emerge as an indispensable area for the subject. Its inclusion would not only change the character of the entire subject of Geography as a science of the Earth, but also help the country to collect the maximum data needed for the micro level planning for the country planners. It is still seemingly obscure but through this dissertation we would like to emphasise that it is inevitable in the present day situation. Inclusion of GIS in the curriculum will make the study of Geography very exciting and useful. More importantly the data acquisition will become very easy. There will be mass involvement of the education system in data collection process. Enormous quantities of accurate data will flow from various institutions with the latest updations. Both the objectives of data collection and organisation will be met without extra effort in collecting data.

What is GIS after all? Nowadays all students are taught what are maps and to what extent they are informative, etc. Think of a map which will give everything and anything whenever you want! Is it not something interesting? Think of geography with all the information you need! The information of a particular man of a country, his state, district, town, his locality then his own house and himself. Is it not exciting! We will be

just crazy to have such an exhaustive coverage of the subject. This will give everything that will be geographical information about the near-surface, above and below the Earth, such as elevation, temperature, population density, literacy, occupation and resources of different types. It will be more so when we know that such things would be possible by application of computer software usage that is specially prepared for this purpose. This software is readily available for their useful application. It is not a dream now. Besides all these, we can be a part in creating this information base and facilitate in further development.

Let us know what **GIS** is. **G**—Geography (The Globe, near-earth, above and below, Map, Layers). **I**—Information (Physiography, Hydrogeology, Soil, Land Use, Resources, Socio-economic parameters). **S**—system (Computer Hardware, Software, Database Libraries). It is presently seen as the most versatile technology option for the policy makers. Spatial Decision Support System (SDSS) is entirely dependent on the relational databases. When the relational databases are easily available for the entire country at the micro-level it would not be difficult for the economists and managers to arrive at the optimum solution for any kind of problem.

If the present stock of situation is taken, we will see that the education system has introduced quite a bit of computer learning in the curriculum. The exposure and the use of computer begins quite early. In many parts of the

country the tie-ups of the schools with the computer training institutes has improved the learning process, too. Now what remains is utilisation of the knowledge and application in proper area that would change to a large extent. Presently, the course of geography invariably contains preparation of maps as a core element, with all the elementary methods dealing with scales, etc. Actually these are also the basics of the preparation of the software with slight application of mathematical principles in various type of maps with layers, supplemented with exact latitude (Lat) and longitude (Long) data that could be collected by using a Global Positioning System (GPS). Maps and map layers are easily dealt where each layer of a map means information on any of the criteria or parameter like roads, watersheds and run-offs, power plants and soil type. If dealt properly, perhaps it would not be difficult to understand that more useful application software also could be developed once the GIS is introduced in its real essence in the course content of geography.

What is the current status of GIS applications? It is quite well developed and prepared for make its appearance as a key element of the course content of Geography, Geology and Geophysics. Many commercial conversions are available at present of use. Some these are ArcInfo, Arc View, Map Info, ArcGIS and GRAM++. The first four of the software/applications have been in use for quite some time while the package of GRAM++ has been developed indigenously by Scientists of our

country. This can be very judiciously used for education and training at different levels and would not be a very expensive affair in any case.

As expected the GRAM++ an acronym for Geo Referenced Area Management also have incorporated many features that would attract any of the students of Geography, Geophysics, Geology, Civil Engineering and Geo-Science. This is a PC-based package that runs on Windows 9x/NT environment unique for its userfriendliness. The key features among these are — drawing of maps on different scales representing them in either Raster form and Vector form depending on the requirement. The Raster form is the usage of scaled pixels for maps. Whereas the Vector form gives the position with respect to a reference point in a frame. The maps thus can have points, lines and polygons. Using raster and vector data it is possible to prepare layouts for visualization. The cartographic outputs can be obtained by using labels, legends, symbols, etc., with desirable scales and projections. GRAM was initially developed after study and usage of the existing packages have been developed in the Indian context suitable to the existing conditions and the kind of requirement that are often to be taken into account. It has also been revised according to the requirement while using it for various purposes resulting to GRAM++. Since the package involves so many other tools than the ordinary map editing or importing and exporting of data. The positional and non-positional data are very nicely manipulated for the graphical representations and outputs desired.

Many features exists beyond the map digitisation and its relational databases. Its use as a decision support system in management is usage of mathematical and statistical applications. Essentially this software is coding in Visual Basic with algorithms in Visual C++ and using MS-Access data. Libraries have been created as ActiveX controls. Image handling tool has been one of the main features in order to handle remote sensing data. Tools exist for transformation, enhancement and classification.

Nowadays the computer learning in school has begun from the primary classes and the teaching of programming with compilers such as Visual C++ and Visual Basic exist as a part of the syllabi of Computer Science in many good schools. So the inclusion of GIS Would be of worth right from the school level. It has been pointed out by some of the top administrative authorities that the planners do not tend to use the modern tools and techniques in planning. How will it be possible unless it finds a place at the grass root level? Perhaps some combinations like Geography, Economics and Mathematics/Statistics would be ideal for good management base. Even otherwise, the inclusion of GIS in the course of Geography and Computer Science will change the present status of these subjects sufficiently. Needless to add that the scope will be broadened with all these essential elements. Relevance, importance and urgency of GIS felt by all the academicians at present is a must for prospective courses of both subjects of Geography and Computer Science.

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Computer Assisted Instruction on Achievement in Science in Schools

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The present-day society characterised by the presence of ever-growing technology and information explosion. An important feature of education has been its use as physical and intellectual tool. Computer is gradually becoming a familiar and potent tool in teaching/learning in Indian schools. Education must reflect the influence of technology. Appropriate computer technology places users in control of their own learning. It encourages both independent and collaborative learning, while extending and supporting the learning process. Teaching through Multimedia offers an interactive environment for all subjects and skills. Young children respond quickly and naturally to appropriate technologies, which frequently offer a high level of physical control and quick

feedback in a variety of forms. Use of technology enhances effectiveness of a learning experience.

Need for the Study

Education for the 21st Century definitely needs a lot of re-thinking on modernisation in the wake of increasing globalisation and setting up of e-communities and readiness for e-commerce. The content and methodology of the present system of education must undergo a metamorphosis. Considerable efforts have been made on revising and updating the syllabus by the agencies of State Board of Secondary Education and the NCERT in the school curriculum. It is a challenging task to change the content and methodology of teaching particularly because of the ever increasing number of students in our classrooms and lack of hardware and software. Nowadays, more and more schools are having computers at the higher secondary schools. Though most of schools use computers to develop awareness and basic skills to work with the systems through hands-on-experiences. The ready-made software for different subjects from Classes I to XII are also available now commercially. A few schools are purchasing and using them to supplement teaching and for the enrichment of the students. The use of Computer Assisted Learning (CAL) in schools is gaining momentum. The investigators of the present study are science teachers, they were interested to conduct a study on the effect of CAL on achievement in Bio-zoology among higher secondary students.

Objectives of the Study

The objectives of the study are

- (i) to find out the effect of Computer Assisted Instructions (CAI) on achievement in four units in Bio-zoology* among higher secondary students.
- (ii) to find out the effect of Computer Assisted Instructions on achievement in the learning objectives as such on Knowledge, Comprehension, Application and Skills.
- (iii) to find out the effect of Computer Assisted Instruction on Achievement in Bio-zoology over lecture method.

Design of the Study

The study was an experimental research. The design of the study was the Pre-Post Equivalent group one. The dependent valuable in the study was the achievement in Bio-zoology and independent variable was the CAI software in Bio-zoology of Students of Class XI.

Sample Selection

The procedure followed for the selection of the sample selected for this experiment was purposive random sampling. There are two Govt. Higher Secondary Schools at Krishnagiri. One was selected as control and another the experimental school. The strength of control group and experimenting group was 34 and 31 students respectively. All the students studying in Bio-zoology at Class XI level were selected as the sample for the study.

Development of Achievement Test

As the ready-made Achievement Test in Bio-zoology (ATB) was not available, the investigator prepared it. It was decided to use only multiple-choice items for the ATB. A deliberate attempt was made to provide adequate weightage to different units while selecting items to prepare ATB. Total items selected from the units were 105. The prepared items were given to the two subject experts who were teaching Bio-zoology in schools, for content validity. Based on their comments the ATB was modified. Then it was administered to 20 students of Class XI for assessing its reliability. The split-half method was followed in the study. The found reliability co-efficient was 85. The result showed that the tool was reliable.

Development of CAI Software

The Computer Assisted Instruction Software on Bio-zoology was developed by the investigator for using it as treatment in the experiment. The preparation of software was in 'Visual Basic'. CAI is a self-instructional process. The development of CAI consisted of two stages. First stage dealt with the preparation of skimmers Programmed Learning (PL) for the selected units in Bio-zoology. The second stage refers the conversion of PL material into computer software. Hence the software would have the features of meaningful increment of information, active participation of the learner, immediate feedback and learning at his own speed etc. The CAI software was administered to 10 students in pilot study. Seven out of 10 have scored

* At the senior secondary stage Zoology is taught as a part of Biology. Bio-zoology here refers to zoology related content in prescribed course of Biology.

around 90 per cent marks. The remaining three scored around 80 per cent. From this it was assumed that the developed CAI Software was valid for external uses.

Data Analysis

Different statistical techniques were used with study for developing and validating the programmed learning material, CAI software and analysing the data. Gain score from pre-and post-test was taken for analysis of data. Percentage Correlation and 't' test were calculated to analyse the data. The results are presented in the following table.

It is understood from Table-1 that the calculated 't' values 6.7863, 2.4033 and 2.2034 for the learning objectives of knowledge, Application and Skills among control and experimental group

are found to be significant at 0.05 level. The higher mean values of the experimental group may be due to the effect of CAI. At the same time there exists no significant difference on 'Understanding' among control and experimental group. This may be understood that both control and experimental group are having similar effect in this aspect.

From the Table 2 the calculated 't' values of 3.2182, 2.9118, 3.3548 and 3.6765 are found to be significant difference at 0.05 per cent level. The higher mean values of experimental group in all units may be due to the effect of CAI:

Table-3 reveals that the observed 't' value of 3.9199 is less than the table value 2.000 which shows that there was significant difference on the achievement among control and experimental group.

TABLE 1
'T' Test for the Gain Score of Control and Experimental Groups on Achievement in the Learning Objectives

Sl. No.	Learning Objectives	Group	No.	Mean	S.D.	Calculated 't' values	Remarks
1.	Knowledge	Control	34	14.8824	2.1525	6.7863	Significant
		Experimental	31	18.3871	2.0109		
2.	Understanding	Control	34	14.9412	1.9242	1.5160	Not Significant
		Experimental	31	15.8387	2.7368		
3.	Application	Control	34	14.8824	2.5060	2.4033	Significant
		Experimental	31	16.4194	2.6369		
4.	Skill	Control	34	11.2353	2.5637	2.2034	Significant
		Experimental	31	12.4839	2.5637		

TABLE 2

'T' Test for the Gain Scores on Different Units of Control and Experimental Group

Unit	Groups	No.	Mean	S.D.	Calculated 't' values	Remarks
I.	Control	34	16.4412	2.6143	3.2182	Significant
	Experimental	31	18.8387	3.3127		
II.	Control	34	12.5588	1.7353	2.9118	Significant
	Experimental	31	14.0323	2.2787		
III.	Control	34	15.7059	1.8235	3.3548	Significant
	Experimental	31	15.3871	2.1802		
IV.	Control	34	13.2353	1.9563	3.0765	Significant
	Experimental	31	14.8710	2.2964		

TABLE 3

'T' Test for the Gain scores of Control and Experimental Group of students in different Units

Groups	No.	Mean	S.D.	Calculated 't' values	Remarks
Control	34	55.9412	6.0242	3.9199	Significant
Experimental	31	63.1290	8.4347		

The higher mean values of experimental group in all units may be due to the effect of CAI.

Findings

Findings of the study are

- Students taught through CAI achieved significant different in the attainment of the learning objectives pertaining to the realm of knowledge, application and skill whereas there was similar effect on 'understanding' among control and experimental groups.
- Significant effect was observed on the achievement in favour of CAI in

all aspects of learning.

- CAI students scored significantly higher marks over the control group students.

Conclusion

Computer Assisted Instruction has made favourable impact on the achievement all the units. When the achievement was analysed as the learning objectives, CAI has produced significantly higher achievement over the control group students on the learning objectives of 'Knowledge' 'Application' and 'Skill' where as similar effect was observed on 'understanding'.

From the study it could be inferred that CAI could be an effective tool to a teacher in the class-room instruction. It may be noted that the government and private institutions are taking steps to equip the schools with hardware and software, mainly to provide an opportunity to

develop awareness as well as hands-on experience with computers. However, it is strongly felt that there must be a change in attitude to promote the use of computers in teaching/learning of different disciplines at all stages of school education.

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Green House Gases (GHGs) and the Perils of Global Warming

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Environment is the most talked about subject today, but at the same time the most ill-understood. Etymologically, the word environment means surroundings. The environment, therefore, refers to the surroundings that is responsible for the survival and development of all living beings and organisms including microorganisms.

The word environment has been perceived differently by different environmentalists and environmental scientists who have come out with different definitions about environment. However, it is worthwhile quoting the following definition given by the environmentalist C.C. Park as far back in time as 1980: 'The environment refers to the sum total of conditions that surround man at a given point in space and time'.

From a scientist's point of view the environment basically consists of a biotic (living) component, a non-biotic (non-

living) component and an energy component. However, when viewed holistically, man and his society cannot be excluded from the ambit of environment as is also reflected in the above-quoted definition of environment.

There is now a growing concern about environmental degradation. Certain gases released into the atmosphere may not only act like pollutants but may also cause hole in the ozone layer or may even lead to global warming. In fact, there are some gases, called green house gases (GHGs), which trap the Earth's heat and do not allow it to go out of its atmosphere. This leads to the warming of the Earth known as global warming. So, the atmosphere acts like a green house. The phenomenon of trapping of heat by the atmosphere is referred to as green house effect. It is interesting to note that the term 'green house effect' was first coined by J.Fourier in 1827. Actually, a green house refers to a house or chamber that houses plants or vegetation in cold countries. A green house is usually made of glass although these days plastic green houses are also in abundant use. Basically, a green house provides a warm environment to the plants which cannot withstand the external harsh conditions of the cold climate.

When solar radiation falls on the green house, the glass walls, which have the property of selective absorption, become transparent to the short-wavelength radiation and therefore allow it to pass through. As a result, the interior of the green house warms up. The plants and the flooring of the green

house chamber emit the long-wavelength heat (or infrared) radiation. The glass walls are, however, less transparent to this kind of heat radiation. The heat from the interior of the green house is, therefore, not allowed to pass through the walls. This process helps to keep the interior of the green house warm, thereby enabling the plants to survive and thrive in the cold, hostile climate.

One actually comes across several practical instances of green house effect in day-to-day mundane life without even realising it. For instance, a car owner leaving his car in the open sun finds the interior of the car badly heated up when he returns to it after some length of time. This is attributed to the green house effect. An identical process occurs in a box-type solar cooker which some families use for the cooking of their food.

Certain gases present in the Earth's atmosphere can too act like the glass walls of the green house producing the green house effect. These gases, which are principally polyatomic in nature, act like green house gases (GHGs). These gases absorb the long-wavelength infrared (IR) radiation emitted by the Earth's surface and reduce its escape by 40 per cent relative to an atmosphere-free Earth.

To understand the mechanism of absorption it will be instructive to note that in addition to the translational and rotational motion, the polyatomic molecules can exhibit vibrational motion too. (On the other hand, the monoatomic molecules have only translational motion while diatomic molecules exhibit translational as well as rotational

motion.) Due to the vibratory motion, the polyatomic molecules possess vibrational energy. In natural operation of the scheme of things, the average energy of the IR radiation matches the vibrational energy of the polyatomic molecules present in the atmosphere. As a result, the IR radiation is absorbed by these molecules which get changed into vibrationally excited molecules. The excited polyatomic molecules by colliding with other molecules convert the excess vibrational energy into heat. This is radiated back to the Earth resulting in a 'heat trap' causing rise in the atmospheric temperature.

The polyatomic gases responsible for green house effect are mainly carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), halons (organic compounds containing bromine and fluorine, such as, dibromo tetrafluoro ethane or $\text{C}_2\text{Br}_2\text{F}_4$), water vapour etc. Sulphur dioxide (SO_2) and ozone (O_3), otherwise regarded as pollutants, may also have the potential of acting like green house gases. It is also suspected that carbon monoxide (CO), the noxious gas that reduces the oxygen-carrying capacity of the haemoglobin, can too act like a green house gas. But, so far the scientists have not been able to come out with a plausible explanation as to how a diatomic gas like carbon monoxide can cause green house effect.

Recently, an international team of scientists has found a new, entirely unexpected green house gas (GHG) in the atmosphere. Known as trifluoromethyl sulphur pentafluoride (SF_5CF_3), the new GHG, that was spotted in the

stratospheric air samples, is a potential infrared absorber-nearly 20,000 times as effective as CO_2 .

The new GHG is an apparent newcomer in the atmosphere. The Antarctica snow samples show that till the late 1960s no trace of this gas was present in the atmosphere. At present, the concentration of this gas in the atmosphere is about 4 parts per trillion (ppt). The gas is presently growing by about 0.008 ppt per year or 6 per cent per year.

Nearly 3900 metric tons of the new GHG is currently present in the atmosphere. However, its concentration is progressively increasing due to the 270 metric tons of emissions regularly reaching the atmosphere every year. Although the amount of this gas currently present in the atmosphere is insignificantly small it has nevertheless a long lifetime of about 1000 years or more. In contrast, CO_2 lasts only about a century in the atmosphere while methane is known to last for hardly a few decades.

The new GHG identified by the scientists is of exclusively anthropogenic origin, originating as a by product or breakdown product of sulphur hexafluoride (SF_6) gas which finds wide applications as an electrical gaseous insulator in switch gears, transformers, accelerators and a host of other high-voltage electrical/electronic equipments. Actually, the high-voltage discharge in such equipments creates SF_5 radicals. Such high-voltage systems, moreover, are likely to contain fluorepolymers which may possibly act as sources of CF_3 groups. The SF_5 radicals attack the CF_3 groups leading to the formation of SF_5CF_3 gas.

Although at present the green house potential of the gas SF_5CF_3 is abysmally low, the scientists opine that it is important to constantly monitor the atmospheric concentration of this gas to guard against its undesirable accumulation in the atmosphere.

As already said, the green house gases have the consequence of causing the phenomenon of global warming. The global climate including rainfall, storms, wind patterns, ocean currents and sea levels may all be adversely affected due to this phenomenon.

The global warming may have the adverse effect of melting the polar ice caps and causing rise in the sea level leading to floods in the coastal areas.

Many computerised models have been used to study the possible effects of global warming. According to the predictions of one of these models, popularly called the circulation model, the global warming may drastically reduce the moisture levels in fertile zones turning many of them into deserts. On the whole, while some places may be affected by floods others may be hit by droughts.

The global warming may also affect the rainfall patterns and the onset of monsoon. This may have adverse consequences, particularly for an agricultural country like ours.

Thus, the warning bell is already ringing. something concrete has to be done to curtail the emissions of GHGs, especially CO_2 , into the atmosphere. Otherwise, the perils of global warming may indeed work havoc on the life in this 'green' habitable planet.

High-Tech Surgery for Restoring Defective Vision

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India is increasingly becoming a country of the near-blind. This is no exaggeration, as the statistics reveal that one out of every four Indian needs vision correction. This correction can be achieved through spectacles, contact lenses or surgery. Some of us, instead of taking the best care of our eyes, end up with optical crutches. No matter how so for attractive the zars of the fashion world try to design spectacles, only the wearer knows it's not quite like the real thing. Pressure of the frame leads to eyestrain, headaches and unsightly marks on the nose. To put an end to this facial accessory, contact lenses have been introduced. These are small lenses that are placed directly on the cornea of the eye. But wearing contact lenses is not like wearing pair of shoes. Persons wearing lenses, soft or disposable, face problems. For example, some find the maintenance of lenses difficult while others have to face problems like infection. In addition, contact lenses are not always an ideal solution if the eyes or atmosphere are very dry.

Finally, we are left with surgery, but eye surgery is something every one is not comfortable with. Nevertheless, high-tech method like Lasik has made eye surgery increasingly safer, almost painless, riskless and quick. Lasik is an extension of the standard method known as PRK—which stands for 'Photoablative Refractive Keratectomy'; where a laser is used to modify the corneal curvature, that is, the angle of refraction. Laser, an acronym for light amplification by stimulated emission of radiation, is produced as a single coherent beam of light of precise wavelength, unlike ordinary light that is incoherent with many wavelengths. PRK method employs a computer-controlled excimer laser beam to burn off minute sections of the cornea. It takes several hundred laser impulses to shape the cornea as desired to correct the visual defect. Unfortunately, this can damage the surface of cornea and lead to complications. These problems can be avoided by using Lasik which stands for 'Laser Associated In-situ Keratomileusis'. This technique also called Flap and Zap procedure, is a brilliant innovation of Pallikaris, an American scientist. This method negates all the disadvantages of excimer laser and involves, correcting the corneal distortion by removing minute quantities of tissue from just below the surface of the cornea rather than from the surface itself, leaving the outer layer intact. Lasik laser procedure involves extensive computer analysis of the eye. After the computer analysis is complete, the spectacle or lens wearer is called for Lasik surgery. Local anaesthetic eye drops are instilled in the

eye to achieve a pain-free procedure. The patient is now asked to lie under the laser machine and fix his gaze at a blinking light. The data of the patient is fed into the computer memory of that laser. A ring is then placed around the cornea which serves as a platform for the automated micro-keratome. With the help of a micro-keratome, a 160 micron flap (comparable to an onion skin) is picked up from the cornea. This flap remains attached at one end so that it can be flipped back like a lid afterwards. Laser is delivered to reshape the cornea to a desired curvature as in PRK. This flap is now repositioned and allowed to dry for a few minutes where due to its intrinsic bonding properties it seals automatically. No stitches are required, as the hydration pressure in the eye is enough to seal back the surgical incision. The excimer produces a non-thermal light beam that eliminates the possibility of thermal damage to the surrounding tissues. Since in Lasik the corneal surface remains intact, there is far less scarring than with PRK. The entire procedure takes about ten minutes. The person has a good vision immediately after the procedure, and routine activities can be started the very next day. However, picking up a good corneal flap and repositioning it back requires greater surgical skill and the use of high-tech microkeratome machine increases the cost of the Lasik surgery. Lasik is ideal for people with Myopia upto 20, Hyperopia upto 8 and astigmatism upto 6 diopter. Minimum age requirements for undergoing this procedure is 18 years, though there is no upper limit for the same. Majority of

the people get rid of their spectacles after Lasik surgery but a small percentage may have a mild variation from their targeted zero correction. In the past five years, Lasik method has been used to treat an estimate 500,000 people worldwide. A decisive factor for success is the surgeon's complete mastery of the complicated technique.

Recent high-tech surgical techniques have also solved the problem of retinal tear or detachment. The damage caused by tear or detachment can be controlled by simply sealing the hole or the tear by laser or cryopathy. In cases where the retinal detachment has already taken place, the surgeon restore to surgery. This involves scleral buckling, in which a surgeon sews a piece of silicon band or sponge over the site of retinal tear. This buckle supports the area till the laser or the cryopathy helps seal the tear. Another way is to inject an air bubble inside the vitreous cavity. After this process-called pneumatic retinoplexy—the patient has to keep his head in a specific position so that the bubble pushes the detached retina against the wall of the eye and disappears on its own. In complicated cases, vitreous surgery is performed to reattach the retina. Here, the vitreous is removed through surgery and the eye is filled with a clear fluid compatible with the eye. Surface tension caused by the fluid or the gas pushes the retina back into position. Over a period of time, the fluid, or air is absorbed by the eye and replaced by its own fluids.

The most common cause of loss of vision in the old age is cataract, that is, gradual clouding over of the natural lens

of the eye. But the high-tech surgery has made the task of removing the cataract easy and painless. This is phaco-emulsification surgery—a very big word that breaks up into phaco (Greek for lens) and emulsification (from Latin *emugere*, 'to milk out'). This is popularly called 'no stitch' cataract surgery or 'drive-back' surgery in the west because the person operated upon can actually drive back to house right after the surgery. This technique leads to an early recovery and gives very rapid improvement of vision on the day one after surgery. The cataract is emulsified—that is, the clouded lens is broken up and drained away through an incision that is only 3.00 mm long. It is performed with an ultrasonic instrument with titanium tip that vibrates at a frequency of 40,000 times per second. When the cloudy lens is all gone, a foldable posterior chamber intraocular lens is implanted through the same small incision. This incision is self sealing. This surgery has the advantage of no stitch, fast healing, minimum induced astigmatism and an early stabilisation of light refraction. Post operative complications are very rare. The procedure results in unaided vision and costs between Rs. 15000 to 20,000. Surgeons do not operate on both eyes together as even in the best hands, there is a 0.5-2 per cent chance of infection. Since the surgery involves the perforation of the globe, there can be bleed in some cases. But these risks are even higher in conventional surgery. The whole procedure takes 7-10 minutes. This technique is useful for all types of

cataracts, except those which are very hard or hypermature. The equipment required for phacoemulsification is sophisticated and costly and surgeon needs more time to master the technique.

In India, due to high cost of phacoemulsification surgery cataract is still treated by conventional surgery, i.e. intracapsular and extracapsular surgery. Intracapsular surgery is a 'large incision' technique. The clouded lens is removed and vision is restored by providing the patient with high powered spectacles. In this case the patient has to wear very thick lenses and sees a world that is magnified and distorted like the images in a carnival fun-house mirror. This technique now has been abandoned in the industrialised world. In extracapsular surgery large incision is given to remove the clouded lens, however, the capsule that holds the lens is left in the original place. Then a tiny artificial lens is implanted. The intraocular transplant restores distortion free vision without the heavy specs — but it requires lot of cutting and stitching. Seven to nine stitches are given and the patient needs as long as two months to regain sight.

Though we have taken big strides in the field of technology yet the fact remains that with existing infrastructure we are able to cater only fraction of what the demand is. Above all, due to heavy costs, not too many patients are encouraged to go for high-tech medical intervention. It is hoped high-tech innovation will become cheaper in coming time and within the reach of common man.

Inquiry for the Science Laboratory Effectiveness of Secondary Schools*

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The useful activities for science education, namely science fair, science exhibition, visits, and science tours are considered to be an integral component of science education. But the place of science laboratory of the secondary school is unique as far as science education is concerned. The science laboratory can wait for its proper student but the students can't wait for appropriate science laboratory. Hence, there should be a bridge between the student and science laboratory.

As Jawaharlal Nehru the first Prime Minister of India has said, "No country can be prosperous without the development of Science and Technology", it is necessary to develop science and technology to make the free India, rich and prosperous. And now, in the 21st century, there is no doubt that the development of science and technology will be an unavoidable pre-requisite for the development of any nation. It is in

this reference that it is necessary for every citizen to practice science and technology in his/her daily life. It is a fact that the children of today are the future of tomorrow, so, now it is a must to educate every child by giving him/her proper education in science and technology. This will help to develop the scientific insight in his/her daily life. Besides this, the principles of science are verified in the science laboratories. If the learners of the secondary level in schools develop the skills of using science and technology and apply them in their daily life, their scientific attitude will be built. The science laboratories in schools can play a crucial role in this endeavour. If the learners are trained in science and technology with adequate hands on experiences in the laboratory, they can solve their personal problems in a scientific way and as trained citizens of the nation, they can also understand the problems of the nation. Thus, the school laboratories are at the root of the development of science and technology. For this reason, the school laboratories should be well equipped. It is interesting to know about the effectiveness of science laboratories of the secondary schools.

In the science laboratory - planning, arrangement, and utility are the strong aspects. If they are in appropriate order, the science laboratory will be effective. So, the inquiry about the science laboratory effectiveness of the secondary schools, and to study the relationship between science laboratory effectiveness

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of secondary schools with reference to (1) planning, (2) arrangement, (3) utility is necessary.

Objectives of the study

1. To develop a Science Laboratory Effectiveness Questionnaire (SLEQ).
2. To validate the tool (SLEQ) Using the Rasch model of item response theory (IRT).
3. To inquire about the science laboratory effectiveness of the secondary schools, to study the relationship between science laboratory effectiveness of secondary schools, and (1) planning, (2) arrangement, and (3) utility.

Hypotheses

To check the invariance of item and person parameter estimations, the following hypotheses were formulated:

1. There will be no difference between the mean Rasch Partial Credit Model (RPCM) item estimates on the SLEQ.
2. There will be no difference between the mean RPCM person estimates on the SLEQ.
3. There will be no significant difference between the mean scores of the rural and urban area at the level of planning on the science laboratory effectiveness questionnaire of secondary schools.
4. There will be no significant difference between the mean scores of the rural and urban area at the level of arrangement on the science laboratory effectiveness questionnaire of secondary schools.

5. There will be no significant difference between the mean scores of the rural and urban area at the level of utility on the science laboratory effectiveness questionnaire of secondary schools.

Method

Descriptive, survey method was applied to the research.

Research area

Science education.

Population and the sample

The sample of the survey was consisted of 200 science teachers from 200 secondary schools of Bhavnagar District of Gujarat state (in A.D. 1999). There were 588 science teachers in the population which is shown in Table 1.

The senior science teachers who were incharge of science laboratory, were selected for the sample.

Tool

The self made questionnaire — Science Laboratory Effectiveness Questionnaire (SLEQ) was applied to examine three dimensions affecting the secondary school science laboratory viz : planning, arrangement, and utility including the fitness of the tool was inquired with the Rasch Model of Item Response Theory.

The test consisted of 32 questions to be answered in 'yes' or 'no' pertaining to the three dimensions of the study, namely, planning, arrangement, and utility. Questions from 1 to 14, 15 to 24, and from 25 to 32 were in respect to these aspects in that order. Each item (question) of the questionnaire was

TABLE 1
Population and Sample of the study

Taluka	No. of schools from rural area	No. of schools from urban area	Total no. of schools	Total no. of science Teacher (Popu.)	Total no. of (sample) science teacher
1. Bhavnagar City	-	44	44	182	44
2. Bhavnagar	07	09	16	35	16
3. Botad	07	11	18	47	18
4. Gadhada	06	06	12	36	12
5. Gariyadhar	06	11	17	45	17
6. Ghogha	03	05	08	12	08
7. Mahuva	12	13	25	90	25
8. Palitana	06	09	15	38	15
9. Sihor	07	07	14	43	14
10. Talaja	07	05	12	25	12
11. Umarala	04	05	09	19	09
12. Vallabhipur	05	05	10	16	10
Total	70	130	200	588	200

assigned as score of 0, 1 points depending on the response ('no', 'yes').

Pilot study

The sample for the pilot study of 22 science teachers working in 22 different secondary schools, out of 30 Gujarati medium secondary schools of Bhavnagar District, was selected randomly. In the sample 12 teachers were B.Sc., B.Ed. and 10 teachers were M.Sc., B.Ed. They were incharge of science laboratories. There were 13 male teachers and 09 female teachers in the sample. Among them, 2 teachers were having 2 years teaching experience, 4 teachers having 5 years, 6 teachers having 10 years, and 10 teachers having

more than 15 years teaching experience. 12 of them were working in rural area while 10 teachers were working in urban area.

Fitness of the tool

A person by item matrix, containing 704 (22 person 32 items) data points was prepared.

The major part of analysis of the data in the pilot study was carried out by the computer programme CREDIT 2 on a personal computer. CREDIT 2 analysed the data using the Rasch Partial Credit Model (RPCM) of item response theory (IRT).

The CREDIT 2 based analysis included the calculations for item and person parameter estimates, standard

errors of item and person parameter estimate, item and person fit statistics, score equivalence table, item probability plots (i.e. item characteristics curve - ICCs), and item information plots.

The standard error, item information plots, and item information indices were used for analysing the data.

Item parameter estimation

The estimation procedure implemented by the programme CREDIT 2 is a generalization of the UCON procedure described by Wright and Stone (cited in Joshi, 1996) for the dichotomous Rasch Model.

Person parameter estimation

The computer programme CREDIT 2 provided individual results in items of raw scores, person parameter — ability estimate (logit), standard error of ability estimate and a statistic summarizing the fit to the model for each teacher of the sample (pilot-study) of 22 for the present tool. These individual results in terms of means, and standard deviation (SD) were calculated.

Data collection

The data on the subject i.e. science laboratory effectiveness was collected on the questionnaire (SLEQ), Prepared by the investigator. First of all the researcher had taken the permission of the sampling schools for the data collection. After taking permission the researcher had personally gone to the teachers of each sample school and gave them the detailed information and got the questionnaire filled by them. Individual information was taken along with the questionnaire, there were different

variables like the educational qualification, gender, rural or urban area.

Method of data analysis

After getting questionnaire filled by the respondents, scoring was done as per the method described for the pilot-study. The data was arranged according to the pre-requirements of analysis.

For the inquiry of the science laboratory effectiveness, mean and SD were used. To examine the significant difference between the rural and urban area at the secondary schools, the mean scores and t-test were applied.

Conclusions

The conclusions of the study were as under:

1. The conclusion of the total sample, which includes 200 science laboratories, shows the middle level of effectiveness.

The mean of total sample was 18.82 shows a middle level of effectiveness of the science laboratories. It can be said that secondary schools of Bhavnagar District do not score high on effectiveness for the science laboratories.

2. There was no significant difference in the mean scores of science laboratory effectiveness between the rural and urban secondary schools of Bhavnagar District.
3. There was no significant difference in the mean scores of the level of planning on the science laboratory effectiveness between rural and urban secondary schools of Bhavnagar District.

4. There was no significant difference in the mean scores of the level of arrangement on the science laboratory effectiveness between rural and urban secondary schools of Bhavnagar District.
5. There was no significant difference in the mean scores of the level of utility on the science laboratory effectiveness between rural and urban secondary schools of Bhavnagar District.
6. There was significant difference at 0.01 level in the mean scores of the level between planning and arrangement on the science laboratory effectiveness of secondary schools of Bhavnagar District.

There was significant difference at 0.05 level in the mean scores of the level between arrangement and utility on the science laboratory effectiveness of secondary schools of Bhavnagar District.

There was significant difference at 0.05 level in the mean scores of the level between utility and planning on the science laboratory effectiveness of secondary schools of Bhavnagar District.

The level of planning shows high level of mean scores. The level of planning was more effective than arrangement and utility on the science laboratory of secondary schools. Besides, the level of arrangement was more effective than utility.

Suggestions

After the analysis of the data and

examining the results of this research project, the researcher wishes to give the following suggestions.

1. The results of this research shows that the laboratories of secondary schools of Bhavnagar District have middle level of effectiveness in respect of the dimensions like planning, arrangement, and utility of laboratories. So the researcher suggests that secondary schools must be provided facilities and impetus to acquire a high level of effectiveness for the science laboratories with respect to these three dimensions.
2. It is observed that the science laboratories of rural and urban secondary schools had no significant difference in effectiveness. So management of urban secondary schools must provide facilities of modern science laboratories.
3. If the suggestions of science teachers are considered in the decision concerning Improvement in the effectiveness of science laboratory, they are likely to be more effective and would work better for utility. Thus, their partnership in the decision making in planning for the science laboratory is necessary.
4. After knowing the level of factors planning, arrangement, and utility affecting the effectiveness of science laboratory, suitable planning, arrangement, and utility should be used and the secondary laboratories should be well equipped.

Educational implications

Secondary schools of Bhavnagar District had not high effectiveness for the science laboratories. It shows middle level of effectiveness. This is not a good situation. The science laboratories are at the root of the development of science and technology. For this reason, the school laboratories should be well effective. There is middle level planning, arrangement, and utility at the science laboratories of secondary schools of Bhavnagar District. Arrangement and Utility are poor dimensions of them. Many schools had not proper

arrangement and utility of science laboratories. We can say that, unless the student will get appropriate amount of practice in science laboratory, he/she will face difficulties in developing science learning. If the science teacher will get appropriate science laboratory, he/she will teach effective science education.

We can suggest that the secondary science education should be more important. Effective science laboratory is more useful in science education. So, efforts for the effectiveness of science laboratory should be created by the management.

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Isolation and Control of Variables by the Biology Teachers

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For quite a long time, science had been defined a '*systematized body of knowledge*'. Many teachers / teacher educators even today cling to this definition of science. Of late, science has been considered as a way of thinking and behaving and it is process and product simultaneously. In fact, true science, resides in its modes of inquiry. There are rather no set steps for the inquiry modes of knowing. 'Actually there is no one method that characterizes science' (Hurd, 1970). Concept of '*the scientific method*', therefore, is a figment of understanding it.

Experimental thinking is essentially tagged to processes of inquiry modes. The following mental functions chiefly constitute the processes of science: Observation; measurement; inference; prediction; formation and testing of a hypothesis; making of interpretations and/or mental models of scientific reality, etc. Testing of a hypothesis needs creation of an experimental setting. True experimental design, depends on

injecting a control group into the inquiry procedures. Isolation and control of variables form a necessary link in an experimental study. This provides determining / establishment of cause and effect relationship between and among the independent and dependent variables.

Inquiry-curriculum theorists emphasize understanding of science instead of inventorying its achievements. Inquiry modes of sciencing provide interactions in building processes as well as in development of higher order conceptualizations. In order to develop/nurture experimental thinking related to isolation and control of variables among the students, it seems desirable, first to assess this ability in postgraduate biology teachers, so that in case of its deficiency, in-service orientation programmes can be planned.

Sample

Twenty postgraduate biology teachers of Kendriya Vidyalayas participated in this study. They had come to Regional Institute of Education, Bhopal to attend an orientation programme in biology during the month of June 2001. Their teaching experience varied from five to fifteen years.

Assessment measure

The following task was adapted (Driver et. al., 1982) to assess sampled teachers' ability to isolate and control of variables.

A house wife lodged some plants of the same species and having same type of soil in pots on the window-sill. Each day she watered them and a little liquid fertilizer was also added.

After few days, all the plants began to wilt. She became interested to know why did the plants wilt. She then produced the following pots:

- A : Water and fertilizer as before;
- B : Water as before, no fertilizer;
- C : Less water than before, fertilizer as before;
- D : Less water than before, more fertilizer than before; and
- E : No water, no fertilizer.

Which two pots (A to E) she needs to select, to find out, if the plants-

- (a) wilted because of too much water ?
- (b) wilted because of the fertilizer?
- (c) were helped to grow because of the fertilizer?

Scoring

Driver et. al., (1982) have suggested that each correctly isolated and controlled variable be awarded a score of one. Therefore, a subject could earn a maximum score of 3. Right answers were

Question (a) : A and C

(b) : A and B

(c) : C and D

Question (a)

It deals with the isolation of the effect of too much water that caused wilting of the plants. None of the sampled teacher selected the right choice of pots of A and C. Eight types of wrong choices were exercised by them in order of A/B 45%; B/C 20%; B/D 10%; and 5% each of

A/E; B/E; C/D; B; and no response. Therefore, all the teachers selected wrong choices of variables.

Question (b)

It is related to isolation of fertilizer as a variable that caused wilting of the plants. Only two teachers (10%) selected right choice of the pots of A and B. On this task as well, these teachers exercised 8 kinds of wrong choices. They were C/D 40%; 10% each for B/E; D and no response. 5% each choice was B/C; B/D; D/E; C; and D. Wrong choices, therefore, were selected to the tune of 90% for this task.

Question (c)

For this question, the effect of fertilizer had to be isolated that promoted plant's growth. 15% of these teachers selected right choices of C and D pots. The rest of them (85%) selected 11 wrong choices of variables. 15% each selected A/B; and A/C variables. 10% each choice was made for B/C and D. While 5% each choice was exercised for A/D; A/E; B/E; D/E, and A; B; and no response. On this task, 5% increase had been registered over task (b) for the correct answer. At the same time number of choices had as well increased by 3(15%) more wrong choices.

Further analysis of the data revealed the following interesting observations:

- (i) None of the Ss scored three marks, i.e. not a single teacher was able to isolate and control variables related to all the three questions. This is as well true for questions a/b; a/c; and b/c;

- (ii) 85% of these teachers failed all the three administered tasks; and
- (iii) An unusually very high per cent of them failed on all the three tasks (100, 90, and 85, respectively).

Discussion

Construction of knowledge does not depend on perceptions and/or on sensations alone. Hence, it is asserted that proper understanding of biological concepts does not result due to S-R connections or by listening to teacher transmitted textbook information. Conceptual change takes place when open searching is done in the form of hypothesis creation and its experimental testing that embraces isolation and control of variables. This ability according to Piagetian (1950) theory of cognitive development banks on hypothetico-deductive reasoning of the learners. Biology/Chemistry postgraduate teachers of JNV's had been found deficient in negotiating Piagetian early formal reasoning, spatial visualization, and co-ordination of horizontality and verticality tasks (Pachaury, 2000). Therefore, the sampled teachers' (KVS) extremely poor performance on higher order thinking tasks like isolation and control of variables does not at all surprise the experimenter.

Extremely bad performance of these teachers, seems to be related to their

learning experiences and socially approved values about its teaching in the schools. This all reinforces their strong liking for imparting content-based biology information to senior secondary students, so that they register its better achievement in the board's examination. Another probable cause for this state of affairs is tagged to an incipient sinistral swing in favour of conceptual structure of the sciences. Consequently, this new venture in teacher education programmes, led to a covert apathy for science of learning by the children. Year after year, this tendency flourished like toadstools and kept on dictating in-service orientations in favour of course-contents only.

The results of this study strong support the contention that these sampled teachers need orientations in process-based biology instruction. Equipping them in how to plan and conduct bio-experiments (isolation/control of variables) would help them in nurturing process skills of their students. It is opined that process-based learning of biology by the students would improve their ability and attitudes to behave in a more responsive manner as consumers of our depleting biological resources. Some of them might as well create new knowledge and better bio-technology for the well being of the mankind harbouring this planet.

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Mathematics and Logic

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Mathematics belongs to every inquiry, moral as well as physical. Even the rules of logic, by which it is rigidly bound, could not be deduced without its aid. The laws of argument admit of simple statements, but they must be curiously transposed before they can be applied to the living speech and verified by observation. In its pure and simple form the syllogism can not be directly compared with all experiences, or it would not have required Aristotle to discover it. It must be transmuted into all possible shapes in which reasoning loves to clothe itself. The transmutation is the mathematical process in the establishment of law." — Peirce, Benjamin.

Logic is the scientific study of conditions of accurate thinking and valid inferences. Mathematics is the only field of knowledge in which logical laws can be applied and the results verified by independent means. Mathematics, in general, is described as deductive science and in every piece of deduction, there are three parts i.e., premises, the process of reasoning and conclusion. The laws of deductive thought are

applied to the premises in order to get the conclusion. The idea of reducing mathematics to logic was expressed by G. Leibnitz (17th Century). The practical realization of the thesis of logician was undertaken at the end of the 19th Century and the beginning of 20th Century by G. Frege and B. Russel.

The axiomatic approach to logic was first propounded by George Boolean Englishman. On this account logic relevant to mathematics is sometimes called Boolean Logic. It is also called mathematical logic or more recently symbolism. With the advent of computer and the study of language in the context of computers, symbolic logic has gained added importance. It is worth mentioning the thought of Leevre Arthur, "Formal thought consciously recognized as such, is the means of all exact knowledge; and a correct understanding of the main formal sciences, logic and mathematics, is the proper and only safe foundation for a scientific education."

Logic deals not only with facts but with relations of statements. Relations or connectives are expressed by symbols but these symbols are not static. For instance, '+' sign used in chemical equation does not mean numerical addition of the quantities. The symbol '-' (minus) sometimes means subtraction and other time means direction. It is by extension of meaning of symbols, that it becomes possible to economise thought not only in mathematics but also in other sciences. It was found that most of the mathematical symbols could be generalized still further so that they could be applied to logical propositions also.

The aim of the mathematician is to place his science on sure foundation. His aim is to prove every proposition with the help of those propositions that have already been proved and to define every word with the help of those words that have already been clearly defined. If this is the aim, mathematician wants to reduce the number of undefined proposition and undefined words as small as possible. Therefore, it becomes necessary for him to investigate into the conditions of valid inferences what is called the science of logic. Therefore, ultimately, the investigation into the foundations of mathematics become an investigation into the laws of thought.

Laws of Statements and Logical Connectives

One of the difficulties in analyzing mathematical rigour and proof is the fact that we must communicate our ideas to each other in an ordinary language. All such languages are full of ambiguities. words have multiple meanings. some meanings are very vague and it is sometime difficult to decide whether or not a given line of reasoning is acceptable. One of the goals of logic is to eliminate these ambiguities by making it clear just how statements are to be constructed, evaluating the concept of truth, and establishing specific rules of inference by which a given argument may be judged as valid or invalid.

Thus, logic is a broad subject, dealing with methods of producing valid arguments. In developing deductive methods and criteria for judging the validity of arguments, logicians have

found it necessary to consider the various ways in which one reasons naturally and extracting those procedures which are good and eliminating those which are not.

The derivable objects of logical calculus are interpreted as statements, formed from the simpler ones by means of propositional connectives and quantifiers. In the context of logic, a statement means a declarative sentence conveying a situation which is neither imperative, interrogative nor exclamatory. Any statement is assumed to be either true or false, or equivalently either valid or invalid. A statement can't be both true and false at the same time. True or false is said to be the truth value of any statement denoted by the symbols T and F respectively.

A statement is said to be **simple** if it does not depend on another statement. For instance,

- (i) New Delhi is the capital of India.
- (ii) The set of natural numbers is infinite.

Compound Statement is a combination of two or more simple statement. For example:

- (iii) $\sqrt{2}$ is an irrational number **and** $\frac{1}{2}$ is a rational number.
- (iv) The school runs **or** a holiday is declared.
- (v) **If** it is Sunday, **then** office may be closed.
- (vi) Sum of real numbers a and b is a rational number **if and only if** a and b are rational numbers.

(vii) All triangles are not isosceles.

In all the above cases, statements are obtained by combining or connecting two simple statements. The phrases or words connecting two simple statements are called logical connectives. Thus, as mentioned above in bold letters, 'and' symbolised as $\wedge$ (conjunction); 'or' as $\vee$ (disjunction); ' $\rightarrow$ ' stand for conditional; 'if... then ...'; ' $\leftrightarrow$ ' for biconditional if and only if; $\sim$ symbol for negation 'Not' are all logical connectives. These connectives assume the values true or false in accordance with the laws defined in tabular forms for each connective.

Truth table of operation $\wedge$ (Conjunction)

Let P and Q be any two statements, then intuitively we feel that $P \wedge Q$ ought to be true if both P and Q are true, otherwise the truth value of $P \wedge Q$ has truth value F (False) as expressed in the tabular form.

Table: 2.1

P	Q	$P \wedge Q$
T	T	T
T	F	F
F	T	F
F	F	F

Truth table of operation $\vee$ (disjunction)

Let P and Q be any two statements, then the compound statement $P \vee Q$ which means "P or Q or both". In mathematics, we use the word or in the inclusive sense. The disjunction is a case where our

intuitive understanding of the connective will be quite adequate to tell us how to make logical definition of the truth value of compound statement as indicated below.

Table 2.2

P	Q	$P \vee Q$
T	T	T
T	F	T
F	T	T
F	F	F

Truth table of operation $\sim$ (negation)

A statement which is modified by the word 'not' is called the negation of the given statement. For example, consider the statement, "Roses are red in colour". Its negation is, "Roses are not red in colour". Generally, in the case of simple as well as compound statements, the phrases, "It is not the case" or "It is false that" are used to express the negation of the statement. For example, consider the statement, "Roses are red in colour and sky is blue in colour". Its negation is, "it is not the case that roses are red in colour and the sky is blue in colour" or "It is false that roses are red and the sky is blue". It is reasonable to define the truth value of negation as given in the Table 2.3.

Table 2.3

P	$\sim P$
T	F
F	T

Truth table of the Connective $\rightarrow$ ("If... then ...")

The motivation for the truth value assignment for the conditional statement is the fact that as intuitively understood $P \rightarrow Q$ is true if Q is deducible from P in some way. Thus, iff P and Q are both true, we want the implication $P \rightarrow Q$ to be true and if P true and Q false, we want the implication $P \rightarrow Q$ ought to be false. Moreover as per the common sense, one may argue that $P \rightarrow Q$ is not applicable whenever P is false. However, in the logical system, we assign truth value to $P \rightarrow Q$ whenever P is false independent of truth value of Q . For the appropriateness of truth value assignment to $P \rightarrow Q$ where P is called antecedent and Q termed as consequent of the conditional, let us cite the following example:

Example: Mohan made a promise stated as : "If I get L.T.C I shall take my family on journey."

This conditional statement has two parts

P: If Mohan gets L.T.C. (antecedent)

Q: He will take his family on journey (consequent).

We get verbal translation of Mohan's promise symbolically as $P \rightarrow Q$. To assign truth values to his assertion, let us analyse the following situations.

- (i) P is true; Then Mohan's
and Q is true assertion is true.
- (ii) P is true; Then Mohan is not
and Q is false keeping his words
 hence his assertion
 is false.

- (iii) P is false;
and Q is true

Then the implication convey the meaning that Mohan is keeping his promise even though he does not get L.T.C. Thus his assertion should be treated true.

- (iv) P is false;
and Q is false

This assertion is also consistent with his promise in negative sense and hence his assertion in this case too should also be taken true.

From the above discussion, it is inferred that $P \rightarrow Q$ has truth value T if P has false value independent of truth values of Q . Thus we define the truth value assignment for the implication $P \rightarrow Q$ as follows:

Table 2.4

P	Q	$P \rightarrow Q$
T	T	T
T	F	F
F	T	T
F	F	T

If $P \rightarrow Q$ and $Q \rightarrow P$, then we say that statements P and Q are logically equivalent expressed through biconditional connective as $P \leftrightarrow Q$ which amounts to the statement pattern $(P \rightarrow Q) \wedge (Q \rightarrow P)$ yielding to the truth value assignment for logical connective (iff) as follows:

Table 2.5

P	Q	$P \rightarrow Q$	$Q \rightarrow P$	$P \leftrightarrow Q[(P \rightarrow Q) \wedge (Q \rightarrow P)]$
T	T	T	T	T
T	F	F	T	F
F	T	T	F	F
F	F	T	T	T

Note: From a given conditional several other conditionals may be constructed by rearranging or negating the terms. For example, by interchanging the antecedent and consequent of $P \rightarrow Q$, converse invariant $Q \rightarrow P$ is obtained. By negating antecedent and consequent of $P \rightarrow Q$, inverse variant $\sim P \rightarrow \sim Q$ is derived. Another variant $\sim Q \rightarrow \sim P$ called contra positive is obtained by negating and interchanging the antecedent and consequent. Whenever a conditional $P \rightarrow Q$ and its converse $Q \rightarrow P$ are both true, the statements P and Q are said to be equivalent as mentioned earlier.

Tautology and Contradiction

Any logical expression involving logical variables termed as statements P, Q, ... and logical operations or connectives is called proposition. Any proposition **t** is called a tautology if it always assumes the truth value T independent of truth values of component statements or

logical variables P, Q, ... Analogously, a proposition **c** is called contradiction if it is false for any truth values of its variables P, Q, ... For example $P \vee \sim P$ is a tautology **t** where as $P \wedge \sim P$ is a contradiction **c** since in the respective last column of their truth tables, truth values T and F occur as shown in the Table 3.1.

All tautologies are true by the virtue of their logical structures and their truth value are independent of truth values of component statements. Tautologies are of utmost importance in drawing conclusions. When the number of sentential variable is small, a truth table may be used to prove easily whether or not a statement is a tautology. The proofs consist simply of constructing the truth table and noting whether the statement has truth value T for all combinations of truth values. Similar is the case with contradictions.

Table 3.1

P	$\sim P$	$P \vee \sim P \equiv t$	and	P	$\sim P$	$P \wedge \sim P \equiv c$
T	F	T		T	F	F
F	T	T		F	T	F

Example 3.1 $\sim P \vee Q \rightarrow [P \rightarrow Q] \equiv t$ (tautology)

Table 3.2

P	Q	$\sim P$	$\sim P \vee Q$	$P \rightarrow Q$	$\sim P \vee Q \rightarrow [P \rightarrow Q]$
T	T	F	T	T	T
T	F	F	F	F	T
F	T	T	T	T	T
F	F	T	T	T	T

Example 3.2 $(\sim P \vee Q) \wedge (P \wedge \sim Q) \equiv c$ (Contradiction)

Table 3.3

P	Q	$\sim P$	$\sim Q$	$\sim P \vee Q$	$P \wedge \sim Q$	$(\sim P \vee Q) \wedge (P \wedge \sim Q)$
T	T	F	F	T	F	F
T	F	F	T	F	T	F
F	T	T	F	T	F	F
F	F	T	T	T	F	F

It is interesting to remark that the negation of any tautology is a contradiction and the negative of any contradiction is a tautology i.e. $\sim t \equiv c$ and $\sim c \equiv t$.

Algebra of propositions (Statements)

To simplify a proposition, one must find another proposition having a simple form in the sense of involving fewer connectives, yet equivalent to the given proposition. We mention below some laws which provide a technique enabling us to construct another equivalent proposition from the given proposition. If P, Q and R are any propositions or statements, then

Commutative Laws

- (i) $P \vee Q \equiv Q \vee P$

- (ii) $P \wedge Q \equiv Q \wedge P$

Associative Laws

- (i) $(P \vee Q) \vee R \equiv P \vee (Q \vee R)$

- (ii) $(P \wedge Q) \wedge R \equiv P \wedge (Q \wedge R)$

Distributive Laws

- (i) $P \wedge (Q \vee R) \equiv (P \wedge Q) \vee (P \wedge R)$

- (ii) $P \vee (Q \wedge R) \equiv (P \vee Q) \wedge (P \vee R)$

Idempotent Laws

- (i) $P \vee P \equiv P$ (ii) $P \wedge P \equiv P$

Identity Laws

- (i) $P \vee c \equiv P$

- (ii) $P \wedge t \equiv P$ where t and c stand for tautology and contradiction respectively.

Negation Laws

- (i) $P \wedge (\sim P) \equiv c$
- (ii) $P \vee (\sim P) \equiv t$
- (iii) $\sim(\sim P) \equiv P$

Absorption Laws

- (i) $P \wedge (P \vee Q) \equiv P$
- (ii) $P \vee (P \wedge Q) \equiv P$

Null Laws

- (i) $P \wedge c \equiv c$
- (ii) $P \vee t \equiv t$

Demorgan's Laws

- (i) $\sim(P \vee Q) \equiv (\sim P) \wedge (\sim Q)$
- (ii) $\sim(P \wedge Q) \equiv (\sim P) \vee (\sim Q)$

Note: For the assimilation of above stated laws, one should take into account algebra of sets since the statement-laws are akin to set theoretic properties by interpreting the symbols $\sim$, $\vee$, $\wedge$ as complementation, union and intersection respectively, and furthermore, by identifying statements with subsets of universal set, tautology t with universal set and contradiction c with empty set.

Application of Logics to Switching Networks

The symbolic logic discussed above has unexpected and powerful application in the designing of the switching networks. A switching circuit is a connection of a finite number of switches. There are only two possibilities for any switch i.e., it is

either 'On' or 'off'. Complicated network can be constructed by joining together two or more given networks in parallel or series. In the logical framework, switches S_1 and S_2 are, connected in parallel are expressed symbolically by $P \vee Q$ and if switches S_1 and S_2 are connected in series, it is expressed by the statement pattern $P \wedge Q$ where statements P and Q are assigned to the switches S_1 and S_2 . Thus following circuit (Fig. 5.1) having switches S_1 , S_2 connected in parallel i.e., has symbolic representation $P \vee Q$ whereas the circuit with switches S_1 and S_2 connected in series (Fig. 5.2), has symbolic representation $P \wedge Q$.

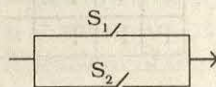


Fig. 5.1

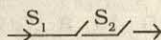


Fig. 5.2

Furthermore, if we represent two switches by S_1 and S_1' , then it implies that S_1' is 'On' whenever S_1 is 'Off' and S_1' is 'Off' whenever S_1 is 'On'. We also agree not to distinguish between two switches which are simultaneously 'On' or simultaneously 'Off' and ascribe the same letter to them as in Fig. 5.5.

Example 5.1 Consider the following circuit diagram involving three switches S_1 , S_2 , S_3 i.e.,

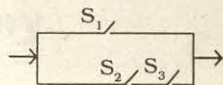


Fig. 5.3

Let us assign statements to these switches as follows:

P : Switch S_1 is 'On'

Q : Switch S_2 is 'On'

R : Switch S_3 is 'On'

This network has symbolic representation $P \vee (Q \wedge R)$.

Using distributive law we have

$P \vee (Q \wedge R) \equiv (P \vee Q) \wedge (P \vee R)$ yielding another network expressed as



Fig. 5.4

Example 5.2 Consider another circuit network involving five switches i.e.,

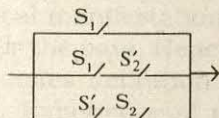


Fig. 5.5

Let us make the following logical arrangement

P : Switch S_1 is 'On'

Q : Switch S_2 is 'On'

$\sim P$: Switch S_1 is 'Off' i.e., Switch S_1 is 'On'

$\sim Q$: Switch S_2 is 'Off' i.e., Switch S_2 is 'On'

We have the following symbolic representation of the network i.e.,

$P \vee (P \wedge \sim Q) \vee (\sim P \wedge Q)$
simplifying, we get

$$P \vee (P \wedge \sim Q) \vee (\sim P \wedge Q)$$

$$\equiv [(P \vee P) \wedge (P \vee \sim Q)] \vee (\sim P \vee Q)$$

D (Distributive Law)

$$\equiv [P \wedge (P \vee \sim Q)] \vee (\sim P \wedge Q)$$

(Idem potent Law)

$$\equiv (\sim P \wedge Q) \vee [P \wedge (P \vee \sim Q)]$$

(Commutative Law)

$$\equiv [(\sim P \wedge Q) \vee P] \wedge [(\sim P \wedge Q) \vee (P \vee \sim Q)]$$

(Distributive Law)

$$\equiv [P \vee (\sim P \wedge Q)] \wedge [(\sim P \wedge Q) \vee \sim (\sim P \wedge Q)]$$

(Demogarn's Law)

$$\equiv P \vee (\sim P \wedge Q) \wedge t \text{ (Negation Law)}$$

$$\equiv P \vee (\sim P \wedge Q) \text{ (Identity Law)}$$

$$\equiv (P \vee \sim P) \wedge (P \vee Q)$$

(Distributive Law)

$$\equiv t \wedge (P \vee Q)$$

(Negation Law)

$$\equiv P \vee Q$$

Thus, finally earlier complicated circuit (Fig. 5.5) involving five switches gets simplified equivalently into simpler one containing two switches only as given in Figure 5.6. Reduction of number of switches to obtain an equivalent circuit is called **simplification** of the circuit as expressed below:

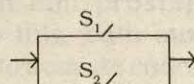


Fig. 5.6

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Pain : Unsolved Mystery

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There is considerable controversy and lack of knowledge about how a stimulus is transformed into an awareness of pain. The anatomy and physiology involved in the reception, transmission, and perception of pain are extremely complex. All pain is interpreted as such in the brain. Pain cannot exist unless impulses reach the higher cortical centres of a conscious individual. An unconscious person does not have pain. Brain identifies the existence and location of pain. Since anxiety, depression, and other emotions usually accompany pain, it is almost impossible to say whether the physiological manifestations reflect the emotions or the pain. Hence, sufferings like pain defies definition and can be subjective. Experience of pain usually occurs in three phases: (1) anticipation of pain, (2) sensation (or presence) of pain, and (3) the after aftermath of pain. All three phases may occur in a matter of seconds, or they may extend over a period of years. These phases may also occur in cycles over a period of hours or years. Certain characteristics of pain have been universally recognized as being important to assess: location,

intensity, quality, onset, duration and variations. But, it is difficult to quantify these characteristics.

Although many exciting discoveries relating to pain have been made, the route by which impulses arrive in the brain is very complex and still not entirely known. But Melzack and Wall-gate-control theory is a successful attempt in this direction. According to this theory, transmission of pain impulses can be modulated by gating mechanism all along the central nervous system i.e. when the gate is open, pain impulses flow through easily; when the gate is closed, no pain impulse flows, through; when the gate is partially open, only some of the pain impulses flow through. Gate theory established that pain is not just a physiological function of tissues, but that psychological variables interact to influence the perception of pain in intensity and quality. Hence pain be made more tolerable by placing the sensation on the edge of awareness rather than at the centre of attention. Thoughts and feelings generated by the circumstances surrounding episode of pain can also influence the gating mechanism.

The pH in the tissue in pain state is highly acidic. The acid metabolites seem to heighten the sensitivity in pain fibres. The acid metabolites are algogenic, capable of provoking pain. They include histamine, kinnins, prostaglandins and serotonin. Pain relieving action of aspirin and other non-narcotic analgesics is due to the blocking of acid metabolite production e.g. prostaglandins. In addition to this, both stress and pain are known to activate endorphin release.

But it is not known to what extent pain intensity triggers endorphin release. Endorphin is a complex of two words, endogenous and morphine, meaning a 'morphine within', morphine being a potent narcotic analgesic. In some people anxiety about their pain releases endorphins hence they may be less sensitive to pain. Pain relieving action of acupuncture as well as low frequency transcutaneous electrical stimulation is also mediated through endorphin release. In chronic pain, endorphin system apparently ceases to function.

Pain is classified according to location as superficial deep-somatic and referred pain. Superficial or cutaneous pain usually refers to pain in the skin and mucous membranes. Pain in superficial tissues can be identified fairly easily and precisely by the patient because of its innervation. Deep somatic pain refers to pain which involves deep structures other than viscera e.g. periosteum, muscles, tendons, fascia and joints. Referred pain may be defined as pain which is present in an area that is removed or distant from its point of origin. Referred pain most commonly is referred from viscera to parietal region.

In clinical practice the patient's pain is either called psychogenic or somatogenic. Somatogenic pain usually is defined more in physical terms referring the physiological processes involving the somatosensory system. Psychogenic pain, on the other hand, usually implies that the pain originate in the mind, that is, it is a somatic delusion. However, Davis (1980) held that the dichotomy between psychogenic

and somatogenic pain is an artificial one because 'all perceptual experience has a physiological basis and all physiological stresses have psychological effects! 'Pure' organic pain, pain sensations that result only from physical stimuli, are as unlikely as 'pure' psychogenic pain. As soon as pain occurs, and at times before, emotions such as anxiety, anger, or depression arise to influence the total pain experience. It is very difficult to authenticate and legitimize the presence of the patients's pain. Proving the presence of pain is so problematic that physicians continue to seek a procedure in laboratory tests that will differentiate between so-called organic and psychogenic pain. Even though physical stimuli for the pain may be absent in psychogenic pain, the emotional stimuli are present and they are conveyed by physiological mechanisms to the level of consciousness or awareness along the nervous system. The location, severity and other qualities of psychogenic pain can be exactly like those of somatogenic pain. Hence psychogenic pain is not simply grief or some other unpleasant emotional experience. In chronic pain patients even psychogenic pain processes start with a 'genuine' organic process. Hence the results of both research and clinical observations regarding mental processes and emotional states associated with pain are not only inconclusive, but in some cases contradictory.

Attempts have also been made to differentiate persons suffering from pain as 'pain patient', 'painful patient', 'pain

prone patient' and 'painful family' Pain patients refer to those who present themselves to doctor with a complaint of pain, seeking relief from it. Painful patient is one whose humanity is intimately related to, or wholly dependent upon his being in pain and suffering. Pain-prone patient is a person who suffers repeated or prolonged pain. In these persons, patients's own special personality affects his experience of pain in complicated ways and organic pathology underlying pain very often is identifiable as a child abuse. Painful families are families in which one or both parents, more frequently the mother, and sometimes more distant relatives such as cousins or grandparents, suffer from recurrent pains and psychogenic problems, recurrent illness, and pseudo-illness. Parents in these families are excessively preoccupied with their children's health and it is unlikely that the children will grow up symptom-free.

These days many hospitals and institutes are running pain clinics

particularly in western countries. These clinics offer a variety of treatment modalities including invasive measures such as medications, acupuncture, and surgery and non-invasive such as biofeedback, self-hypnosis and nutritional counselling. The greatest service that a doctor or nurse can provide to any patient is to listen and believe what the patient says about pain. However, when it is suspected that a patient does have a pain problem resulting from mental processes, extreme respect and diplomacy must be consciously employed during the assessment process. Though the recent exciting discoveries regarding pain have made numerous major contributions to the relief of pain yet current information available on the neuroanatomy, physiology and psychology of nociception and its relation to pain perception is far from complete. Complicated diagnostically elusive pain problems still persist and this diagnostic dilemma often results in treatment dilemmas causing embarrassment to patient, doctor and the nurse.

Problems Related to the Use of Audio-Visual Aids in Science Teaching

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The use of sensory aids have a strong psychological and scientific base in the teaching-learning process as they give vividness to learning situation and also effect economy of time. Science is no doubt full of facts, concepts and principles, but its teaching is not just giving out information about them to students. The ultimate purpose of science teaching is to educate pupils and make science a part of their life activity. This can be achieved by providing science education based on the needs, interests and abilities of the learners. For this, science teachers should plan and formulate an effective teaching programme based on the basic principles of good teaching.

The scientific approach regards teaching as a 'System' comprising of different sub-systems and believes that intelligent, creative and mechanical

interaction among the sub-systems leads to effective teaching. The teacher and the learners are such sub-systems besides materials and aids; information and skills. The teacher is an important factor in the class room and has four different components at his/her disposal—

1. The language which functions as the medium.
2. The content material that is to be put across.
3. The class room techniques which he employs.
4. The teaching materials which are his creative resources to co-ordinate these components in such a way that his work emerges as most productive.

The teaching materials consist of language materials and instructional aids. Instructional aids are those materials which a teacher uses to supplement his teaching for making it more realistic and effective. These often provide the basis, the starting point and the points of reference of the student's and the teacher's teaching-learning activities in the class room.

It is beyond doubt that in science learning, the first-hand experience is the best type of educative experience and for such an experience, students should be allowed to see, hear, feel, smell and taste. But in many cases it may not be practical and desirable, and also at times, may prove expensive and dangerous. Hence, to give a clear and complete concepts of the scientific phenomena, vicarious or substituted experience should be

provided to the students. Such, substitutes for reality are often termed as Audio-Visual Aids.

Importance of Audio-Visual Aids in Science Teaching

The use of audio-visual aids is based on the assumption that clear understanding originates from sense experience. Besides providing vicarious experience, audio-visual aids are helpful in fixing up new learning, contribute to increased retentivity, cultivate scientific temper and also promote the development of higher faculties by stirring the imagination, thinking process and reasoning power of the students. They provide the stimuli for learning 'how', 'why', 'when' and 'where'. They attract the interest and attention of the students and thus, act as best motivators and also as an antidote to the disease of verbal instruction. Thus, we can say that audio-visual aids are those sensory devices which are used for better communication of ideas to initiate learning, to clarify, establish and correlate concepts, interpretations and appreciations and which help in completing the triangular process of learning i.e. motivation-clarification and stimulation by making the learning experience more concrete, more realistic and more dynamic. Thus, use of audio-visual aids in science teaching becomes inevitable.

Both, the Education Commission (1964-66) and the National Policy on Education (NPE 1986) and as modified in 1992 have highlighted the role of audio-visual aids in education and have laid great stress on their use to make

teaching-learning more effective. The Education Commission even observed that it should indeed bring about an educational revolution in the country and stated that the supply of teaching aids to every school was essential for the improvement of quality of teaching.

It is quiet evident that the importance of use of audio-visual aids in the teaching-learning process has been recognised and widely accepted, yet it will be generally agreed that the impact of these activities on teaching practices in the vast majority of our schools has not been very significant. In the average school today, instruction still follows a mechanical routine and is heavily infected by the disease of verbalism and therefore remains as dull and uninspiring as before. This leads to the development of negative attitude among students towards science. Measures have been taken from time to time for adoption of technology in education but still a large gap is felt between the learning outcomes formulated and those achieved within the class room.

To translate formulated task into reality, the basic need is to find out the reasons for less use of audio-visual aids in teaching as it is only when problem areas are identified, the government and the policy makers and all involved in the education process can take corrective measures in this regard.

It is with this objective in view that a study was carried out to find out the problems related to the use of audio-visual aids in teaching science subjects at the secondary level. The study was confined to Lucknow city.

Problems Related to the Use of Audio-Visual Aids

The analysis of the data, collected under the present study, showed that only 15.57 per cent teachers of Lucknow city use audio-visual aids in class room teaching whereas 84.42 per cent do not use them. This certainly is a dismal fact and points towards the extent the disease of verbalism has grasped our education system as also it indicates some loopholes within our system and to which the system itself is falling prey to. Though audio-visual aids were found to be available in 72.5 per cent schools but only 24.59 per cent teachers proclaimed it to be 'good', 32.78 per cent as 'fair' and a large number of teachers, 42.62 per cent stated the condition and availability of teaching aids as 'poor'. In majority of schools, there is total absence of projected aids and hence, teachers are compelled to stick to the conventional method of teaching in class room. They have only non-projected aids of the traditional type at their disposal and that too of inferior quality and not easily accessible. Thus, teachers regarded 'absence of sufficient equipment and material' that is user-friendly, easily accessible and according to requirement, as one of the major and primary cause of not using audio-visual aids in class room teaching besides other causes.

A favourable data which emerged during the study is that professional training of teachers has definitely a positive effect on their performance as only trained teachers were seen to use audio-visual aids. As education is a life long process, training of teachers should

also be a continual process. In the light of this view, in-service training of teachers acquires a pivotal position. In-service training provides update information to teachers and therefore it should be an essential and integral part of teacher-training programme. But the study indicated that the in-service training of teachers acquires a backseat as 96.72 per cent teachers mentioned that never in their school any seminar or workshop is organized to acquaint them with upcoming desirable techniques to be adopted in the class room teaching process.

Another area of problem which the teachers mentioned is 'large class size' and 'lack of time'. Large class size and more number of working periods increase the workload of teachers and they are bound to be less incorporate audio-visual aids in their teaching. A teacher is inspired to use audio-visual aids more frequently with less number of students as then the class room is efficiently manageable.

More than 38 per cent teachers remarked the 'traditional type of work' as one of the prominent causes. Today, teaching is confined to transfer of information directly from the textbooks to the students in the class room by the teachers. Lecture method is largely employed for this purpose. There has been an explosion in the field of science and technology and the new techniques have not found ways into the training course of teachers as well. The training course of teachers still sticks to the traditional syllabus. The traditional approach being followed and, moreover, the training programme becoming more

and more academic than practical tends one to link these factors to the present grim situation.

Teachers also remarked that curriculum is heavy and that departing away from the old method and adopting new techniques requires bold steps. According to them there is also lack of initiation and motivation within the school premises itself, which prevents them from going ahead with new techniques and therefore, they stick to the age-old methods. They complained that their principals do not ever take any interest in their teaching methodology and never motivate them to adopt new techniques.

When teachers were enquired about the library facilities in their schools, 42.62 per cent teachers revealed that there is no such facility in their school. So, if in schools, library is non-functional, how can one expect students to read beyond their text books and also in absence of good related reference books for teachers, it cannot be expected from them to bring novelty in their teaching.

For this and other problems, the underlying major constraint is 'lack of finances.' 35.24 per cent teachers revealed that they never prepare any aid due to lack of funds. Teachers who draw a reasonably handsome salary at times, use their own money for the continuation of the thought but this cannot be expected from teachers who are poorly paid.

Besides above mentioned factors, 81.96 per cent teachers regard our examination system as one of the causes of not facilitating teachers to use Audio-Visual Aids. The traditional system of

examination encourages memorization of bookish knowledge and it does not permit first-hand experience of things and practical application of knowledge acquired. Also no credit for genuine hardwork and non-co-operation of parents often disheartens the teachers.

Concluding Remarks

Thus, these are some of the major problems related to the use of audio-visual aids in science teaching. Observations showed that use of audio-visual aids by teachers even though in low percentage is strongly backed by the consideration that science teaching is incomplete without its use. Hence, overhauling the education system according to the present need gains more importance. In this respect, the Education Commission (1964-66) recommended re-organisation of Teacher Education curriculum and suggested training of teachers in the use and preparation of simple and improvised teaching aids and use of school workshop and programme of work experience for it. The National Council of Teacher Education (NCTE) in 1978 provided a set of guidelines for adoption of task-oriented and performance-based curriculum. NPE (1986) also recommended the same. Time and again, emphasis has been laid on lifelong learning of teachers where pre-service and in-service education are inseparable. The role of District Institutes of Education and Training (DIETs), Colleges of Teachers Education (CETs) and Institutes of Advanced Study Education (IASEs) in providing in-service training to teachers needs more strengthening. The function of

Educational Technology cells and State Institutes of Educational Technology, previously established needs to be revaluated and updated.

At the same time, we should not look at one aspect i.e. overhauling teacher education only as the triangular linkage between educational policy, school curriculum and teacher education is inevitable because each of the three is related to the other two. Reforms are needed in all the three but the important

tool for bringing about the change is the teacher we produce in our training institutions. We have to produce what is needed and in demand, to improve the quality of education. Proper planning on the part of the government and proper co-ordination at various levels is required to improve conditions. Last but not least, implementation procedure has to be accelerated to introduce dynamism and speed the reformative process without further delay.

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Finding Sum of Infinite Geometric Series by Experiment

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Most of us carry a notion that Mathematics is concerned only with abstract ideas and we cannot have practical activities and/or demonstrations for teaching and learning of concepts in mathematics. This perception also holds for dealing with the arithmetic progression (A.P.), geometric progression (G.P.) or harmonic progression (H.P.). As a result, a majority of teachers use only the chalk and talk method to explain the basic ideas concerning the series corresponding to these type of progressions and to solve the problems based on them. The only method employed to find the sum of different series is to apply the formulae in a mechanical manner.

However, here an attempt has been made to demonstrate through a set of activities an activity method to arrive at the sum of an infinite geometric series.

We begin with a specific example of a geometric series and then proceed in steps to generalize the results to deduce the formula for the series.

An infinite geometrical series is written as

$$a + ar + ar^2 + ar^3 + \dots$$

Sum of the above series $S = a/(1-r)$
if $|r| < 1$

Activity No. 1

Aim: To find the sum of the series

$$1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \frac{1}{256} + \dots$$

Material required: Four sheets of paper. Besides the experimenter three more persons are to be involved in the activity.

Procedure: The activity aims at to distribute 4 sheets of paper equally amongst 3 persons.

As we have 4 sheets of paper with us and we have to distribute them amongst 3 persons, to begin with we give one sheet of paper to each of the three persons involved in the activity. Now, we are left with ONE sheet of paper. It is difficult to divide this single sheet of paper equally into 3 parts. So, we cut the sheet into 4 equal parts bisecting it twice and then give one piece to each.

This time each one has receive $\frac{1}{4}$ th of the initial sheet of paper and the experimenter is left with $\frac{1}{4}$ th of the

sheet. So, each person has received $1 + \frac{1}{4}$. Repeating the above process again each one will get $\frac{1}{16}$ th of the sheet of paper received by each at the beginning (Fig. 1).

Observations

Repeating in this manner each person will receive the pieces of paper in the following manner:

$$1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \frac{1}{256} + \dots$$

Calculations: Now the question is how much of a sheet of paper one got?

Total Number of sheets of paper distributed = 4

Number of persons who received them = 3

Result

Obviously 4 sheets of paper were equally distributed amongst 3 persons and

hence each must have $\frac{4}{3}$ sheets of paper.

Inference: As per the formula for the sum of the series, $S = \frac{4}{3}$ which is the

same as obtained through the activity.

(Here $a = 1$ and $r = \frac{1}{4}$)

Activity No. 2

Aim: To find the sum of series—

$$1 + \frac{1}{2} + \frac{1}{4} + \dots$$

Material required: Two sheets of paper. Besides the experimenter one more person is to be involved.

Procedure: The person involved in the activity is given half of the sheets of paper the experimenter possesses at any instant of time and every time the remaining sheet or the part of the sheet is further divided in two equal parts.

So, first we will give one sheet of paper and are left with one sheet. Now, the second sheet of paper is cut into two parts and one part is given to the person,

so he gets $\frac{1}{2}$ the sheets of paper. In all the number of sheets of paper received

are $1 + \frac{1}{2}$. These steps are repeated over and over again so that after every

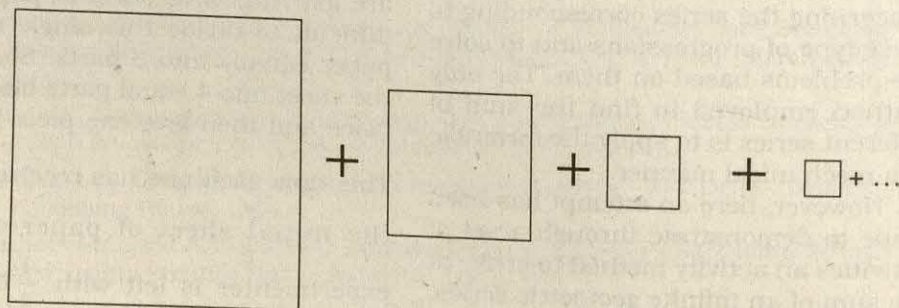


Fig. 1

step $\frac{1}{2}$ of the sheet left at the end of previous step is handed over to the person.

Observations

In this manner total number of sheets

the receiver gets: $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots$

Calculations: Now the question is how much of a sheet of paper one got?

Total Number of sheets distributed = 2
Number of persons who received them = ONE

Result

Obviously 2 sheets of paper distributed to only one person and hence he must

have $\frac{2}{1} = 2$ sheets of paper.

Inference: As per the formula, for the sum of the series $S = 2$, which is the same as obtained through the activity.

(Here $a = 1$ and $r = \frac{1}{2}$)

Activity No. 3

If in the above experiment one begins with one sheet of paper, the series will be as:

$$\frac{1}{2} = \frac{1}{4} + \frac{1}{8} + \dots$$

One can generalize the outcome of the above activity by assuming that a single sheet of paper can be cut into any number of equal parts. Suppose the sheet of paper is cut into n equal parts to distribute it among $(n - 1)$ persons even if it may be possible to cut the sheet of paper into $(n-1)$ equal parts, the paper

has to be cut into n parts, to have the G.P. series].

Generalization of the Result

Aim: To find the sum of series:

$$1 + \frac{1}{n} + \frac{1}{n^2} + \frac{1}{n^3} + \frac{1}{n^4} \dots$$

Material required: n sheets of paper. Besides the experimenter $(n - 1)$ more persons are to be involved in the activity.

Procedure: Distribute n sheets of paper amongst $(n-1)$ persons in the following manner: To begin with give one sheet of paper to each of the $(n-1)$ persons. Now, cut the remaining one sheet of paper into n equal parts and give one part to each of the $(n-1)$ person. Now each one has

got $1 + \frac{1}{n}$. Next, cut the remaining $\frac{1}{n}$ th

part of the sheet of paper again into n equal parts and again give one piece each and go on repeating this.

Observations

Thus, the total number of sheets received by each person will be

$$\frac{1}{n} + \frac{1}{n^2} + \frac{1}{n^3} + \frac{1}{n^4} \dots$$

Calculations: Now the question is how many sheets of paper each person received?

Total Number of sheets distributed = n
Number of persons who received them = $(n - 1)$

Result

Obviously n sheets of paper were equally distributed amongst $(n-1)$ persons and

hence each one must have $\frac{n}{(n-1)}$ sheets of paper.

Inference: As per the formula, for the sum of the series $S = \frac{n}{(n-1)}$ (Here

$a = 1$ and $r = \frac{1}{n}$) which is the same as obtained through the activity.

In the above illustrative cases we have taken n as a positive integer, now to have n as a negative integer i.e. $a = 1$, and $r = \left(-\frac{1}{2}\right)$ we can perform the activity in the following manner.

Activity No.4

Aim: To show the sum of the series:

$$1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \dots$$

Material required: One sheet of paper. Besides the experimenter one more person is to be involved in the activity.

Procedure: To begin with, the experimenter hands over a sheet of paper to the person involved in the activity. The person after receiving the sheet of paper cuts it into two equal parts and returns one part to the experimenter. The experimenter again divides the piece of paper in two equal parts and hands over one part to the other person who in turn divides it into two equal parts and returns back one part to the experimenter. This process is repeated over and over again.

Observations

Thus, the person receives:

$$1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \dots$$

of the sheet of paper while the experimenter receives:

$$\frac{1}{2} \pm \frac{1}{4} + \frac{1}{8} \pm \frac{1}{16} \pm \frac{1}{32} \pm \dots$$

Calculations: Now if we compare the portion of the sheet of paper received by the other person at every stage we find that it is two times of that received by the experimenter. Thus, the person has

received $\frac{2^{\text{rd}}}{3}$ of the sheet of paper and

the experimenter has the remaining $\frac{1^{\text{rd}}}{3}$

part of the paper (Note that at the end of even number of steps in the process of distribution, the ratio of the portion of the sheet of paper received by them is in the ratio of 2:1 and hence the person

is having $\frac{2^{\text{rd}}}{3}$ and the experimenter is

having $\frac{1^{\text{rd}}}{3}$ which explains the above conclusion).

Result

Thus, the sum of the series :

$$1 \pm \frac{1}{2} + \frac{1}{4} \pm \frac{1}{8} + \frac{1}{16} \pm \frac{1}{32} + \dots = \frac{2}{3}$$

and the sum of the series:

$$\frac{1}{2} \pm \frac{1}{4} + \frac{1}{8} \pm \frac{1}{16} + \frac{1}{32} \pm \dots = \frac{1}{3}$$

Inference: As per the formulae for the sum of the series, we find that for the

1st series the sum is $S_1 = \frac{2}{3}$ (Here $a = 1$

and $r = -\frac{1}{2}$) and sum of the 2nd series

$$S_2 = \frac{1}{3} \text{ (Here } a = \frac{1}{2} \text{ and } r = -\frac{1}{2}\text{).}$$

Activity No. 5

Aim: To find the sum of series :

$$1 \pm \frac{1}{4} + \frac{1}{16} \pm \frac{1}{64} + \frac{1}{256} \pm \dots$$

Material required: One sheet of paper. Besides the experimenter two more persons are to be involved in the activity.

Procedure: In this activity, the first person is given a sheet of paper which he cuts, into four equal parts. He retains

three parts and returns one part i.e. $\frac{1}{4}$ th

of the sheet of the paper to the other. The second person also cuts the given piece of paper into four parts, retains its three parts and gives one part back to the first. The process continues in this manner.

Observations

Thus, the first person has received piece of paper as follows:

$$1 - \frac{1}{4} + \frac{1}{16} - \frac{1}{64} + \frac{1}{256} - \dots$$

while the second person has received :

$$\frac{1}{4} - \frac{1}{16} + \frac{1}{64} - \frac{1}{256} + \dots$$

Calculations: Here, initially the first person is having $\frac{3}{4}$ of the sheet of paper

while the second person is having $\frac{3}{16}$ of the paper i.e. the ratio of the paper received by them is in the ratio $16:4 = 4:1$ and hence at the end, the first person

is having $\frac{4}{5}$ th and the second person is

having $\frac{1}{5}$ th of the sheet of paper.

Result

The first person has received the piece of paper as the sum of the series:

$$1 - \frac{1}{4} + \frac{1}{16} - \frac{1}{64} + \frac{1}{256} - \dots = \frac{4}{5}$$

and the second person has received the piece of paper as the series:

$$\frac{1}{4} - \frac{1}{16} + \frac{1}{64} - \frac{1}{256} + \dots = \frac{1}{5}$$

Inference: As per the formula, for the sum of the series, we find that for 1st

series the sum is $S_1 = \frac{4}{5}$ (Here $a = 1$ and

$r = -\frac{1}{4}$) and sum of the 2nd series is S_2

$$= \frac{1}{5} \text{ (Here } a = \frac{1}{4} \text{ and } r = -\frac{1}{4}\text{).}$$

Generalization of the Result

Aim: To find the sum of series:

$$1 - \frac{1}{n} + \frac{1}{n^2} - \frac{1}{n^3} + \frac{1}{n^4} - \dots,$$

where n is to be any integer.

Material required: One sheet of paper. Besides experimenter, two more persons are to be involved in the activity.

Procedure: In this activity the first person receives one sheet of paper and then he cuts it into n equal parts. Retaining $(n-1)$ parts of the sheet of paper, the first person gives away one part i.e. $\frac{1}{n}$ th of the paper to the other.

The second person also cuts the part of the paper received into n equal parts. After retaining $(n-1)$ parts of these with him, he gives away one part to the first and the process continues in this manner.

Observations

Thus, the first person has received the pieces of paper as follows:

$$1 - \frac{1}{n} + \frac{1}{n^2} - \frac{1}{n^3} + \frac{1}{n^4} - \dots$$

Second person has received

$$\frac{1}{n} - \frac{1}{n^2} + \frac{1}{n^3} - \frac{1}{n^4} \dots$$

Calculations: First person is having $\frac{(n-1)}{n}$ sheet of the paper as compared

to the second person who has $\frac{(n-1)}{n^2}$

portion of the sheet of the paper. In other words, the ratio of the sheets of paper received them is $n^2: n$ or $n:1$ and hence

the first person is having $\frac{n}{n+1}$ and

second person is having $\frac{1}{(n+1)}$ of the sheet of paper.

Result

The first person has received the piece of paper as the sum of the series:

$$1 - \frac{1}{n} + \frac{1}{n^2} - \frac{1}{n^3} + \frac{1}{n^4} - \dots = \frac{n}{(n+1)}$$

second person has received the piece of paper as the sum of the series:

$$\frac{1}{n} - \frac{1}{n^2} + \frac{1}{n^3} - \frac{1}{n^4} + \dots = \frac{1}{(n+1)}$$

Inference: As per the formula for the sum of the series; for the 1st series we get

$$S_1 = \frac{n}{(n+1)} \text{ (Here } a = 1 \text{ and } r = -\frac{1}{n} \text{)}$$

and for the 2nd series, we get

$$S_2 = \frac{1}{(n+1)} \text{ (Here } a = 1 \text{ and } r = -\frac{1}{n} \text{)}$$

It is hoped that these activities would be helpful to the teachers to introduce the concepts relating to geometric series to the children through a play-way (Activity) method. It is envisaged that adoption of this method in classroom will certainly create an interest for learning the concepts among the students and in the process also help to drive away uncalled for fear towards learning of mathematics. As these topics are included at the secondary/senior secondary stages, it is expected that this activity based approach may be fruitful for the teaching and learning community.

The Fascinating Journey of Chromatography

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Chromatography has numerous applications in biological and chemical fields. It is widely used in biochemical research for the separation and identification of chemical compounds of biological origin. Chromatography is employed to analyse complex mixtures of hydrocarbons. As a separation method, chromatography has a number of advantages over other techniques such as crystallization, solvent extraction and distillation. It is capable of separating all the components of a multicomponent chemical mixture without requiring an extensive foreknowledge of the identity, number or relative amounts of the substances present. It is versatile in that it can deal with molecular species ranging in size from viruses composed of millions of atoms to the smallest of all molecules — hydrogen — which contains only two atoms. Furthermore, it can be used even with large or small amounts of material. Some forms of chromatography can detect substances present at the picogram (10^{-12} gram) level, making this method a superb trace analytical

technique extensively. It is used in the detection of chlorinated pesticides in biological materials and the environment, in forensic science, and in the detection of both therapeutic and abused drugs. Its resolving power is unequalled among separation methods.

Chromatography is defined as a technique for separating the components or solutes of a mixture on the basis of the relative amounts of each solute distributed between a moving fluid stream, called the mobile phase, and a contiguous stationary phase. The mobile phase may be either a liquid or a gas, while the stationary phase may be either a solid or a liquid. The kinetic molecular motion continuously exchanges solute molecules between the two phases. If, for a particular solute, the distribution favours the moving fluid, the molecules will spend most of their time migrating with the stream and will be transported away from other species whose molecules are retained longer by the stationary phase. For a given species, the ratio of the time spent in the moving and stationary regions is equal to the ratio of its concentrations in these regions, known as the partition coefficient. A mixture of solutes is introduced into the system in a confined region or narrow zone (the origin), whereupon the different species are transported at different rates in the direction of fluid flow. The driving force for solute migration is the moving fluid, and the resistive force is the solute affinity for the stationary phase; the combination of these forces, on manipulation by the analyst,



produces the separation of various components.

The first purely pragmatic application of chromatography was with dyes. Various dye mixtures were tested by dipping strings or pieces of cloth or filter paper into a dye vat. The dye solution migrated up the inserted material by capillary action, and the dye components produced bands of different colours. In the 19th century, several German chemists carried out several experiments to explore the application of chromatography. They observed, for example, the development of concentric, coloured rings by dropping solutions of inorganic compounds onto the centre of a piece of filter paper. A treatise was published in 1861 describing the method and giving it the name "capillary analysis."

The discovery of chromatography is generally attributed to the Russian botanist Mikhail S. Tsvet, because he recognized the physicochemical basis of separation and applied it in a rational and organized way to the separation of plant pigments, particularly the carotenoids and the chlorophylls. Tsvet's book, published in 1910, described a technique that is used today in essentially the same form. He packed a vertical glass column with an adsorptive material, such as alumina, silica, or powdered sugar, added a solution of the plant pigments to the top of the column, and washed the pigments through the column with an organic solvent.

The pigments separated into a series of discrete coloured bands on the column, divided by regions entirely free

of pigments. Because Tsvet worked with coloured substances, he called the method chromatography (from Greek words meaning colour writing). Tsvet's development of chromatographic procedures was generally unknown to chemists in the Western world because he published either in German botanical journals or in Russian works. In 1931, chromatography emerged from its relative obscurity when the German chemist Richard Kuhn and his student, the French chemist Edgar Lederer, reported the use of this method in the resolution of a number of biologically important materials. In 1941 two British chemists, Archer J.P. Martin and Richard L.M. Synge, began a study of the amino acid composition of wool.

Their initial efforts, in which they used a technique called liquid-liquid countercurrent distribution, failed to give them adequate separation. Therefore, they conceived of an alternative method in which one liquid was firmly bound to a finely granulated solid packed in a glass tube and a second liquid, immiscible with the first, was percolated through it. Silica gel served as the granular solid. Martin and Synge pictured silica gel as composed of water tightly bonded to the crystals of silica. The mobile phase was chloroform. Their work with this technique was remarkably successful. Although their method was mechanically identical with Tsvet's approach, it was innovative as it involved the concept of a stationary liquid (water) supported on an inert solid (silica), with the result that the solute molecules partitioned between the

stationary liquid and a separate mobile liquid phase (chloroform).

The technique used by Martin and Synge came to be called partition chromatography. At that time, they suggested that the moving phase could well be a gas. It is a historical oddity that this idea was overlooked for nearly a decade, possible because of the war, until Martin in collaboration with the British chemist Anthony T. James initiated studies of gas-liquid partition chromatography. In 1952, Martin and Synge were awarded the Nobel Prize for their work, perhaps not so much for the newness of the technique but for a model that suggested other systems, a mathematical theory, and an applicability to amino acid and peptide separations with far-reaching impact on biochemical studies.

The initial partition-chromatography system presented difficulties because of lack of reproducibility in the properties of the silica gel and lack of uniformity in the packing of columns. Partly for this reason, Martin and his co-workers worked out a new procedure in which the stationary medium was a sheet of filter paper. The paper was thought of as water bonded to cellulose, providing another partition method. The technique gave the desired reproducibility, and from the beginning of 1940s, paper chromatography found wide application in the analysis of biologically important compounds, such as amino acids, steroids, carbohydrates and bile pigments. In this field, to a large extent it replaced the column technique initiated by Tsvet.

Motivated probably by the same drawbacks to column chromatography, two Soviet pharmacists, Nikolay A. Izmaylov and Maria S. Shrayber, distributed the support material as a thin film on a glass plate. The plate and support material could then be manipulated in a fashion similar to that of paper chromatography. The results of the Soviet studies were reported in 1938, but the potential of the method was not widely realized until 1956, when the German chemist Egon Stahl began intensive research on its application. This system became known as thinlayer chromatography (TLC).

Yet another chromatographic technique, gas chromatography, was first carried out in Austria in 1944 by the chemist Erika Cremer, who used a solid stationary phase. The first extensive exploitation of the method was made by Martin and James in 1952, when they reported the elution gas chromatography of organic acids and amines. In this work, small particles of support material were coated with a nonvolatile liquid and packed into a heated glass tube. Mixtures injected into the inlet of the tube and driven through by compressed gas appeared in well-separated zones. This development was immediately recognized by petroleum chemists as a simple and rapid method of analysis of the complex hydrocarbon mixtures encountered in petroleum products. British Petroleum Co. and Shell Oil Co. immediately began basic research in their own laboratories. Various instrument manufacturing companies envisaging an extensive

market, also made major contributions.

In 1957, while doing a theoretical study of gas chromatographic columns, Marcel J.E. Golay, as a consultant for the Perkin-Elmer Corporation, concluded that a very long column (90 to 180 metres or 300 to 600 feet) of narrow-diameter tubing (internal diameter of 0.25 millimetres with its wall coated with a thin film of liquid would yield superior separations. Fortunately, at about the same time, detectors with extremely low limits of detection, which could sense the small sample sizes required by these new columns became available. These capillaries, or Golay columns, now called open-tubular columns and characterized by their open design and an internal diameter of less than one millimetre, had an explosive impact on chromatographic methodology. It is now possible to separate hundreds of components of a mixture in a single chromatographic experiment.

Molecular sieves are porous substances that trap a mobile-phase gas. Large molecules cannot enter the pores. Therefore they flow unimpeded through the system. Small molecules are interrupted in their migration as they meander in and out of the pores by diffusion. Molecules of intermediate sizes show different rates of migration, depending on their size. In 1959 Per Flodin and Jerker Porath in Sweden developed cellulose polymeric materials that acted as molecular sieves for substances dispersed in liquids. This extended the molecular weight range of chromatography to polypeptides, proteins, and high-molecular weight

polymers. The generic term for such separations is size-exclusion chromatography (SEC).

In 1964, an American chemist, J. Calvin Giddings, referring to a theory largely worked out for gas chromatography, summarized the necessary conditions that would give liquid chromatography the resolving power achievable in gas chromatography, that is, very small particles with a thin film of stationary phase in small-diameter columns. The development of the technique now termed high-performance liquid chromatography (HPLC) depended on (i) the development of pumps that would deliver a steady stream of liquid at high pressure to the column to force the liquid through the narrow interstitial channels of the packed columns at reasonable rates and (ii) detectors that would sense the small sample sizes mandated. At first, only adsorptive solids were used as the stationary phase, because liquid coatings were swept away by the mobile phase.

Previously gas chromatography had employed chemical bonding of an organic stationary phase to solids to reduce adsorptive activity; Istvan Halasz of Germany exploited these reactions to cause a separation based on liquid solution effects in the bonded molecular layers. These and similar reactions were employed to give firmly attached molecules that acted as a thin film of solvent in liquid systems. These bonded phases gave high-performance liquid chromatography such scope and versatility that the technique is now a dominant method for separations.

Ion exchangers are natural substances. For example, certain clays or deliberately synthesized resins, containing positive ions (cation exchangers) or negative ions (anion exchangers), that exchange with those ions in solution have a greater affinity for the exchanger. This selective affinity of the solid is called ion, or cation exchange chromatography (IEC). The first such chromatographic separations were reported in 1938 by T.I. Taylor and Harold C. Urey, who used a zeolite. The method received much attention in 1942 during the Manhattan Project as a means of separating the rare earths and transuranium elements, fission products of uranium and other elements produced by thermonuclear explosions. Ion-exchange chromatography can be applied to organic ion separations and is of special importance for the separation of amino and nucleic acids.

The solubility of solids in gases at high pressure had been observed as early as 1879. In 1958, the British scientist James Lovelock suggested that gases above their critical temperature (i.e., the temperature above which a liquid phase cannot be produced by increasing the pressure) might be used at high pressure as mobile phases. A substance in this state is termed a supercritical-fluid. At very high pressure, the density of the fluid can be 90 percent or more of the liquid density. The German chemist Ernst Klesper and his colleagues, working at the Johns Hopkins University, were the first to report separation of the porphyrins with dense gases in 1962. Carbon dioxide at

400 atmospheres (One atmosphere equals 760 millimetres, or 29.92 inches, of mercury; standard sea-level pressure is one atmosphere) is a typical supercritical-fluid mobile phase. In an extreme case, Giddings and his group used gases at pressures of up to 2,000 atmospheres to chromatograph carotenoids, sugars, nucleosides, amino acids, and polymers. Supercritical-fluid chromatography bridges a gap between gas chromatography and liquid chromatography. In gas chromatography, concentration of solutes in the gas phase is achieved with increased temperature. Supercritical-fluid chromatography achieves this result with increased pressure so that thermally unstable compounds may be analysed. Additional advantages include increased speed and resolution.

A technique exhibiting great selectivity, affinity chromatography, was first described by Pedro Cuatrecasas and his coworkers in 1968. In these separations, a biomolecule such as an enzyme binds to a substrate attached to the solid phase while other components are eluted. The retained molecule can subsequently be eluted by changing the chemical conditions of the separation.

Another separation technique is based on the fact that the velocity of a fluid through a tube is not uniform. In the region immediately adjacent to the wall the fluid is nearly stationary. At distances farther from the wall, the velocity increases, reaching a maximum value at the centre of the channel. In 1966, Giddings conceived the idea that a field,

electrical or gravitational, might be used to selectively attract particles to the wall, where they will move slowly through the system. Diffusion, away from the high concentrations at the wall, into faster inner streams would enhance migration. The net effect would yield differential migration. A thermal gradient between two walls has also been used. This recently developed technique is called

field-flow fractionation. It has been termed one-phase chromatography because there is no stationary phase. Its main applications are to polymers and particulate matter. One phase chromatography has been used to separate biological cells, sub cellular particles, viruses, liposomes, protein aggregates, fly ash, colloids and pigments.

Uniform Usage of Scientific Literature Common to Different Disciplines of Science

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In recent years, due to enormous prospects in inter-disciplinary areas, there has been a move for cross-boundary thinking and the application of concepts in one discipline to the solving of problems in another discipline. Success of this move is facilitated only if uniform units, terms, data and representation of concepts are incorporated in learning materials such as textbooks, and laboratory manuals. However, survey of the literatures of different disciplines of science i.e. Chemistry, Physics and Biology at Secondary and Senior Secondary levels, reveals that there are some variations in the use of units, terms, data and representations of concepts in different disciplines. Here, on the basis of a survey, some of these areas have been identified and accordingly recommendations have been made. The work is not exhaustive. Some more areas can be traced and necessary uniform changes can be effected in the literature of different disciplines.

Units: Although there is a complete shift from imperial system to metric system in the literatures of different disciplines, yet it has been observed that even in metric system CGS and MKS both schemes are followed. Now, there is universal acceptance for following SI (Système Internationale) units only. Seven SI base units are given in Table 1. Decimal fractions or multiples of SI units are expressed by putting certain prefixes before the names of the units. The various prefixes are given in Table 2. Application of these prefixes can be illustrated by taking a few examples. A hundredth of a metre corresponding to 10^{-2} is centimetre for which symbol cm is used. For 10^3 metre we use the term kilometre and symbol as km.

The unit of bond length in chemistry literature now is written in SI units i.e. picometer (pm). However, in biology literature different bond lengths are given in Angstrom ($\text{\AA}$) Unit, for example C-C bond length $1.5\text{\AA}$. This should be written as 154 pm. Also, in biology and at times in chemistry literature, unit of wavelength is given in $\text{\AA}$ and somewhere in m μ . But now this unit has been discarded and nm (nanometer) SI unit is followed.

There are some SI derived units also. These units are obtained by combination of base units. For example, physical quantity, volume is expressed as m^3 . For many years in all disciplines of science, the fundamental unit employed for measuring volume of liquids was 'litre'. However, for scientific purposes the convenient unit is cubic decimetre (dm^3). But now 'litre' has been accepted as a special name for cubic decimetre by

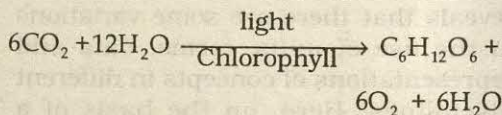
discarding the original definition of the litre. Original definition of litre was "the volume which is occupied by one kg of water at 4°C". Due to this definition, relationship between litre and cubic decimeter holds as 1 litre = 1.000028 cubic decimetre. Nonetheless, it is recommended that only cubic decimetre unit should be used to express the results of high precision.

Physical Constants: It has been found that in the literature of different disciplines different values for physical constants (for same units) and different units for the same physical constant have been followed. It is suggested that the same SI units and same certified values should be used.

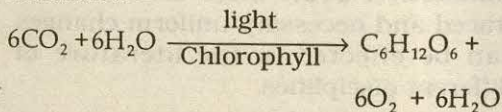
Symbols: It has been found that all science disciplines have not adopted new changes recommended by different international organisations for symbols and names of elements. The symbols of elements with atomic number 104, 105, 106, 107, 108 and 109 are; Rf (Rutherfordium), Db (Dubnium), Sg (Seaborgium), Bh (Bohrium), Hs (Hassium), Mt (Meitnerium) respectively (accepted by IUPAC Bureau, 1994). It is to be added here that no differences have been found regarding the symbols and names of elements having atomic numbers from 1 to 103. The charge on a cation e.g., cation of calcium should be represented as Ca^{2+} (formerly Ca^{++}) and charge on an anion e.g., anion of borate should be represented as BO_3^{3-} (formerly BO_3^-). Gramm and litre are now assigned the symbols g (formerly gm) and L (formerly l) respectively.

Terms: Some scientific terms in different disciplines bear different names. These should be uniform and as per recommendations of International Organisations. For example, optical density should be replaced by absorbance and molar extinction coefficient as molar absorptivity. It has been found in biology literature that discarded terms; optical density and molar extinction coefficient are in vogue. The term volumetric analysis was formerly used but it has now been replaced by titrimetric analysis since it is considered that the latter expresses the process of titration rather better while former may be confused with the measurement of volume, such as those involving gases. The same changes should be brought about in the literature of different disciplines. The terms, atomic weights and molecular weights have been changed to atomic masses and molecular masses respectively.

Representations of Concepts: Process of Photosynthesis is dealt with, both in chemistry as well as in biology. However, reaction representing the photosynthesis has been differently given in different disciplines. It is correctly represented as:



However, just to satisfy the requirement of balancing the equation, in some books, the equation has been written as :



Such representations create misconceptions amongst students. A perusal of some books of biology indicates that "preparation of solution of copper sulphate", is presented as "preparation of solution of CuSO_4 (to express in formula form). While, in formula form it should be $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. (However, it may be mentioned that nowhere preparation of solution of anhydrous copper sulphate, CuSO_4 , is required). This is misrepresentation of the chemistry concept.

Synthetic and Analytical Data: It has been found that the processes of synthesis and analysis bear different expressions of concentrations of solutions

TABLE 1
Base SI Units

Quantity	Unit	Symbol
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s (Sec)
Electric Current	Ampere	A
Temperature	Kelving	K
Luminous intensity	Candela	cd
Amount of substance	Mole	mol

of reagents. It has been found that in some biology and physics textbooks, solutions have been given in ppm or in $\mu\text{g/l}$ while in chemistry these are expressed in molarity or normality. It has been recommended by international body that concentrations of solutions should be expressed in molarity and the same should be followed in literature of all disciplines which will facilitate direct use of data from one discipline to another.

TABLE 2
Prefixes for Expressing Decimal
Multiples of Units

Prefix	Symbol	Multiple
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^9
mega	M	10^6
kilo	K	10^3
hecto	h	10^2
deka	da	10
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	M	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Teacher Involvement to Evaluate Science Achievement

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Much is written about using standardized and state mandated tests to measure student growth in science. Little, however, is written about using teacher developed tests to measure student science achievement in the classroom. Too frequently, standardized tests and state mandated tests omit learner progress in the every day learnings in science achievement in the classroom. Teacher developed tests can be more valid and reliable than either standardized or state mandated tests. Standardized tests are global and do not have accompanying objectives for the teacher to use in teaching science. State mandated tests may have accompanying objectives which teachers may use to gauge their teaching. The teacher may then teach in a manner whereby the state mandated test might have rather high validity since what is taught may be

tested when using the state mandated test. Selected states omit science content and skills in the mandated tests. The feeling then might well be that science is not as important as reading and mathematics, for example.

There is probably no better way to write valid test items than the classroom teacher doing the writing who knows and understands what has been taught in the classroom. The science teacher also has understandings of what the developmental level of the student is when writing appropriate test items. Thus, test items need to be written on the reading and understanding level of the students who are to take the test.

Not many teachers, however, are acquainted with standards to use in test writing.

Standards for Test Writing

The National Research Council (NRC) has just released publication of *Classroom Assessment and the National Education Standards* (National Science Teachers Association, 2001). Six goals are listed in the introduction of this publication. These are—

- Articulate a research based rationale for helping teachers improve classroom assessment.
- Clarify the concept of effective classroom assessment.
- Provide illustrations and guides to the development and selection of assessment processes and tools.
- Assist teacher educators and staff developers who will include assessment in their work with prospective and practicing teachers.

- Address issues that school and district decision makers face in their efforts to improve classroom assessment.

What students learn each day in ongoing science lessons and units of study is important. A single percentile given to show student results on a standardized or state mandated test for an entire school year, or other selected interval of time, does not provide a comprehensive picture of the learner's achievement in science (Ediger, 1990, 241-246). To use either of these tests to reveal learner progress in science has the following weaknesses —

1. multiple choice test items are generally used for student responses to indicate what has been learned. These are paper/pencil test items to measure facts, concepts, and generalizations acquired by students. Major emphasis may be placed here upon measuring factual information achieved by students since this is the easiest kind of content to measure in a multiple choice test.
2. hands on approaches in science teaching and learning might well be greatly minimized or ignored since their strengths and weaknesses cannot be machine scored. A science teacher who has stressed a hands on approach in student learning in the classroom may find the multiple choice test items tend to measure verbal intelligences such as reading largely or only.
3. no exceptions may be made for individual differences among

students. Thus all students have the same amount of allotted time to complete the standardized or state mandated test, all experience the same directions for test taking, all responses are assessed using the same answer key, and all respond to the same kind of test items. Selected students need more test taking time than do others as well as to have directions explained more thoroughly for taking the test. Then too, there may be more than one correct answer than what is presented in the assessment key. Reading multiple choice test items may not be a favourite way of revealing what has been learned in science. A handicapped student, especially, may need special accommodations.

4. science as a curriculum area may not appear on a state mandated test since major emphasis is being placed upon measuring reading and mathematics achievement. Standardized tests, if they do contain test items pertaining to science, may have too few test items pertaining to this vital area of academic achievement.
5. validity may well be lacking if the test stresses abstract learnings such as students reading and responding to multiple choice test items and the classroom teacher having emphasized concrete and semi-concrete approaches in teaching science.

A sampling of every day science achievement of students may be incorporated into a science portfolio. The portfolio, as an example, may contain

the following entries:

1. snapshots of hands on approaches from ongoing lessons and units of study.
2. written work pertaining to summaries; outlines; book reports; as well as expository, creative, and narrative writings.
3. a video tape of collaborative endeavours of students to notice the quality of interactions.
4. tape recordings of oral presentations such as a book report.
5. drawings of construction items made for science experiments and demonstrations.
6. dramatizations, evaluated on a five point scale, pertaining to a unit on famous scientists, for example.
7. self evaluation of students in terms of quality criteria.
8. art products such as murals, diagrams, and other illustrations developed of what was studied in science units of study.
9. test results of classroom developed tests measuring achievement in ongoing units and lessons.
10. student/teacher planning of what is left to learn within a specific unit in science. A carefully designed rubric may be used to assess the quality of each portfolio (Ediger, 2001, 150-155).

Multiple Intelligences Theory

Multiple Intelligences Theory (Gardner, 1993) indicates that there are numerous

possibilities for students to reveal in achievement. Here, students may use their own individual strengths to indicate achievement through the following ways:

1. verbal intelligences such as in reading and responding to test items.
2. logical intelligence as in reasoning to secure information.
3. musical/rhythmical such as in writing lyrics and putting the words to music to reveal what has been learned.
4. intrapersonal intelligences whereby the strengths lie within the individual working by the self to indicate achievement from a lesson or unit of study.
5. interpersonal intelligences in which a learner best reveals learnings obtained through collaborative endeavours.
6. bodily/kinesthetic whereby the student indicates what has been learned through manual dexterity. There are a plethora of ways here for students to show achievement in science units such as in constructing models and objects, making science equipment, and doing projects.
7. scientific intelligences which is truly the heart of the science curriculum as in objective thinking about nature and the natural world.

The student with teacher guidance may select the approach(s) to be used to reveal what has been learned in science

lessons and units of study. This puts more responsibility upon the student, rather than upon test writers far removed from the local classroom, in deciding how to be assessed to indicate achievement. Each of the above named intelligences possessed by a student may be used to show progress in the science curriculum.

To use multiple intelligences theory requires in-service education for teachers. Classroom teachers need to study, see models of multiple intelligences theory in operation to assess learner achievement, and eventually implement with mentor assistance diverse facets of this philosophy of evaluation. In-service education is necessary then for teachers to be able to use new procedures in the assessment process.

Learning Styles Theory in the Assessment Process

Under which classroom environmental conditions do students achieve more optimally? Learning styles theory has much to offer in thinking about the learning environment for students in the classroom. Searson and Dunn (2001) in their research have identified factors which assist or hinder individuals in the classroom in achieving as optimally as possible:

1. acceptable noise levels, temperature readings, as well as formal versus informal seating arrangements.
2. emotional elements such as conformity versus nonconformity, as well as preferences for choices as to what to learn.

3. sociological factors such as studying alone or with others as well as preferring collegial relations versus structure with a more authoritative teacher.
4. physiological factors such as using auditory, tactual, and/or kinesthetic ways of learning. Included too are moving around or sitting still as well as eating versus not eating while concentrating on the task at hand.
5. psychological factors such as being an analytic learner who focuses on a step by step fashion which leads to an understanding, as compared to global learners who desire to understand what is learned and how it relates to themselves before focusing on facts. Analytic students respond best to printed words whereas global learners respond better to illustrations and pictures.

Workshops and faculty meetings are needed for teachers to become thoroughly familiar with learning styles theory of teaching and learning as well as using its components in the assessment procedure. Teachers need to consider learning styles theory when evaluating under which conditions students do best in achieving objectives in science instruction.

Written Tests in the Science Curriculum

There are selected criteria which need to be used by teachers in writing valid and reliable test items to measure learner achievement and progress. Quality test items then need to be in the offing for assessment results to be useful

for the science teacher. Poorly written, vague items will not provide the useful information needed to design the science curriculum. Which are the selected criteria for the teacher to use?

Multiple choice test items are used very frequently by writers of standardized and criterion referenced tests. Teacher written multiple choice test items should possess the following:

1. they should contain a stem and four plausible responses. Four is not a magic number, but if there are three responses, then the student has a better chance of guessing the correct answer. If five responses are in the offing, it might be quite complex in writing each as being plausible or rational.

The following is a model multiple choice item:

Which is *incorrect* in naming the three states of matter?

- (a) solids
- (b) rocks
- (c) gases
- (d) liquids.

There is only one correct answer in that rocks are not one of the three states of matter. The test item is quite factual. However, there are vital facts for students to understand and use in developing increasingly a more complex science vocabulary. Thus, there are a plethora of liquids, solids, and gases for students to encounter in a quality, sequential curriculum. Then, too, relevant facts are the building blocks for higher levels of cognition.

2. no clues are to be given when the student encounters sequential multiple choice test items. Thus, test item number one should not provide a clue as to which is the correct response for test item number two, and others sequentially.
3. each stem needs to be grammatically correct with the four plausible responses —
Three major classification of rocks are
 - (a) sandstone, basalt, and marble.
 - (b) igneous, metamorphic, and sedimentary.
 - (c) liquids, solids, and gases.
 - (d) conglomerate, magma, and shale.
4. the test items need to be arranged in ascending order of complexity. The reason for this being psychological in that the easier test items may build self confidence within students to tackle the increasingly more complex test items sequentially.
5. written test items must cover what has been taught in the classroom so that increased validity is in evidence.
6. peer review of test items may be advisable to take out the weaknesses in a multiple choice test.
7. balance among different topics covered in science instruction need to appear on the test. If environmental education has been taught in class for example, then related test items need to appear on the test. Face validity is then in evidence (Ediger, 1994, 1-4).

8. feedback from student test results should be used to pinpoint weaknesses and thus reteach that which is needed.
9. printouts of learner test results provide a basis for assessment of the quality of test items. If too many miss an item, perhaps it needs to be revised to make it more meaningful.
10. tests are an integral part of instruction and should be used to improve the curriculum, not to make comparisons among students. Learning opportunities should be used to encourage student progress in science (Ediger, 1994, 24-25).

Teacher Observation of Students in Science Achievement

Leadership is certainly needed from teachers and the school principal to use quality criteria to ascertain student achievement in science (Ediger, 1999, 1-5). Test results may well be worthless unless the standards used in measurement and evaluation to determine student science achievement possess face validity as well as reliability, such as test/retest, alternate forms, and/or split half. There are a plethora of factors which need to be incorporated into the writing of quality tests including being on the present reading level of students who will be taking the test. Individual differences should be provided for including variable time limits for students individually who need more time to complete a test.

To harmonize a hands on approach in teaching/learning in science with the assessment process, the teacher may

use observational techniques. The following criteria may be used in the observational process by the science teacher when students are doing hands on science —

1. how well a learner is identifying problems to solve in science.
2. how effective the student is in gathering information directly related to the problem.
3. how proficient the student is in achieving an hypothesis.
4. how well the learner does in testing and evaluating the worth of the hypothesis.
5. how capable the student is in modifying the hypothesis, if necessary.

Teacher observation may be used to determine how well a student is doing in each of the five above named categories. An additional vital item to observe is how well students are using science equipment and materials in problem solving experiences.

Metacognition in Science

Metacognition skills are important to use in the evaluation process. Metacognition deals with thinking about thinking. Early in the child's school experiences, he/she should be aided to achieve as optimally as possible (See Allen, Spring, 2001). The science teacher needs to provide a model to assist students to reflect upon what has been achieved in science in an ongoing lesson or unit of study. This provides opportunities, not only to reflect upon what has been acquired, but also for the student to think about what is left to learn.

Motivational factors arise here in that the learner feels a sense of accomplishment as well as there being more to achieve. Relating that which has been achieved with what is left to learn makes for connections of the older learnings with the new. Review within the reflection process is a powerful factor in retention of subject matter, skills, and attitudes, as well as creating a desire to continue achieving. Too frequently, individuals believe that what has been learned will remain there for retrieval. But forgetting and problems in retrieval are forthcoming. For metacognition to become an important factor in self evaluation, the student needs to —

1. be responsible for his/her own achievement in science.
2. trust the self, with teacher guidance, to develop quality criteria in and for self evaluation.
3. lean upon the self to evaluate, assess, and accomplish.
4. monitor the self to determine if science goals of instruction are being achieved.
5. rehearse, analyze, and synthesize objectives, learning opportunities, and assessment procedures with each being vital in teaching and learning.

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Some Thoughts about a Mathematics Laboratory

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1. A mathematics Laboratory is primarily a laboratory in which experiments are performed with mathematical objects viz. numbers and geometrical shapes in order to discover patterns, make conjectures, do more experiments to verify the conjectures or to find counter-examples and if no counter-examples are found, to try to prove the conjectures. It is a place where the students get the thrill and excitement of discovering mathematical results which may not be new in mathematics, but which are likely to be new for the students.

There can be no mathematics laboratory without experiments.

2. Some persons regard a mathematics laboratory as a place where charts and models are made by students, teachers and even parents to make abstract ideas of mathematics relatively concrete and thus more easily understandable by the students. The students find preparing these charts and models an enjoyable

experience and these make mathematics learning exciting to them. This activity also represents experimentation to find the best means of communicating mathematical ideas to young students.

3. In the same spirit, a mathematics laboratory is a place where in place of charts and models or in addition to charts and models, the students make use of calculators and computers to do experiments to learn mathematics faster and in a really enjoyable and thrilling manner. Here the students also use calculators and computers to do experiments with numbers and geometrical shapes in a much faster manner and this accelerates the process of discovery of new mathematical results.

4. Just as charts and models can enable students to visualize mathematics, computer graphics can also be used to visualise mathematics on the computer screen even better and faster. A mathematics laboratory is a place where mathematics teachers knowing computer graphics, can try to make excellent graphics visible and do experiment with them to choose those which are most important.

5. An alternative view of a mathematics laboratory is that it is a place where students are taught the *process of mathematics* rather than the *product of mathematics*. It is a place where they learn both experimental and theoretical aspects of mathematics in an integrated manner. Here they both make conjectures and prove them. Theorems are not just stated and proved, these are arrived at through experiments and the

method of proof is also clear from the understanding of the method in which the experiments are performed.

6. The mathematics laboratory can also be regarded as a place where problem solving and problem posing are emphasized much more than learning theory and solution of standard problems and even committing these solution to memory. Normally in the mathematics classroom, the teacher teaches the theory and solves some examples and the students are asked to attempt more problems at home, where they try to solve these problems by themselves or with the help of their parents and tutors.
7. In a mathematics laboratory, the students solve the problems in the laboratory itself. They can even discuss the solutions among themselves and they can try to solve the problems by different alternative methods of solution. When they get stuck up, they can get help from the teacher who examines their solutions, finds errors if any, and gives them hints for further solutions of problems. The teacher helps the students in their struggle to solve problems, but he does not spoon-feed the students by giving them complete solutions. Thus, in a laboratory, learning of mathematics takes place through interaction among the students themselves and the interaction of the students with the teacher.
8. In a mathematics classroom, a teacher speaks and the students listen. In the mathematics laboratory, students think, teacher does not speak, but helps the students whenever such help is needed.
9. Mathematics laboratory is not a place where charts and models are stored. Such a place may be called a mathematics museum or a mathematics gallery, but it is certainly not a mathematics laboratory. A mathematics laboratory is a place where charts and models are made, it is not a place where they are stored. Similarly it is a place where computer programmes and computer graphics are made and not just bought and stored.
10. A mathematics laboratory can be compared to an artist's studio, where the artist experiments with artistic designs with paints and brushes. The gallery where he displays his art products can be compared to mathematics museum. One can learn painting by working in a studio and not just by visiting an art gallery. Similarly one can learn mathematics more by working in a mathematics laboratory, than by visiting a mathematics museum.
11. Nobody learns to play cricket by seeing other players playing the game; one can learn it only by playing the game oneself on the cricket field, making mistakes in learning and improving style of playing. Similarly one can learn mathematics by working in a mathematics laboratory, solving problems, doing experiments and not by just studying solved examples alone.
12. In the same way, a mathematics laboratory can be compared to the classroom where music is taught and learnt rather than to a place where music cassettes are played.

13. In a mathematics laboratory student's and teacher's creativity and originality are at their best. In a mathematics classroom, there is almost no scope for originality and creativity. There it is all conformity to standard methods of learning and teaching.

14. The object of teaching mathematics is to produce creative and original thinkers who can solve new problems with full confidence. All such new problems cannot always be solved analytically or theoretically. Students have very often to solve simpler versions of these problems experimentally and then try to generalise these solutions to get the solutions of the original problems.

15. Mathematics is as much an experimental science as physics or chemistry or biology. Intuition and inductive logic play here also an active role. However, in mathematics education, we do not place enough emphasis on the experimental method with the result that students develop math-phobia. However, in a mathematical laboratory, students enjoy learning the process of mathematics and this joy counters the fear of mathematics that pure deductive methods instil in the students.

16. Every experiment in a mathematics laboratory should have very clear-cut objectives. These may include:

- A deeper understanding of the concepts already taught to the students.
- Understanding of applications of mathematics.

— Understanding some new topics which require only the knowledge of mathematics learnt in the classroom, but whose understanding will greatly enhance the joy of learning mathematics.

— Understanding some phenomena in the environment which are apparently mathematical, but which are not studied in the normal classroom learning.

— Giving mathematical experiences from which students can abstract results and see that mathematics is an abstracting science.

17. In a mathematics laboratory, students are actively, emotionally, intellectually involved in the learning process and whatever is learnt with such involvement is not easily forgotten and is fully assimilated by the students.

18. In problem solving sessions in mathematics laboratories, senior students may be employed to help junior students in solving these problems. This will be cheaper than using the regular teachers and this will also help the senior students in becoming clear about the concepts they have to explain to the junior students.

19. Mathematics laboratories can take the help of art and workshop teachers and others to improve the quality of the charts and models prepared by the students. Similarly they can take the help of computer scientists in the preparation of computer programmes and computer graphics for use in the mathematics laboratory.

20. Students have to record their experiments in practical note books in the same way in which they record the results of science practicals, that is they have to give the name of the experiment, objective of the experiment, equipment needed, method of carrying out the experiment, calculations done, results obtained, precautions necessary and possible improvements in carrying out the experiment.
21. In a mathematics laboratory students have to think, talk, discuss among themselves discuss with the teacher, interpret the results, think of new experiments and thus they become active partners in the learning process.
22. It is strange that all these years, in spite of our system suffering from mathphobia in a bus way, we have not thought of starting mathematics laboratories which can possibly remove the main causes of mathphobia.
23. The mathematics laboratory is not yet a part of the examination system, though the NCERT in its National Curriculum Framework has recommended that a mathematics laboratory should be established in every school and in the examination scheme it should have the same weightage as science laboratories. However it is only a matter of time before the CBSE and other boards of secondary education include mathematics laboratory as a part of the examination system. But whether they do it or not, our schools can start mathematics laboratories for students of all classes, except possibly 10th or 12th, immediately and arrange their time table in such a way that the students of each section of a school spend at least one period a week in the mathematics laboratory, doing experiments, discovering new results and learning the use of calculators and computers in solving mathematical problems and in discovering new results.
24. Introduction of mathematics laboratory may mean removal of some redundant topics from the syllabus. There are so many topics in the present syllabus which are being taught just because of tradition, but which have lost all relevance in modern times. We can easily find time for mathematics laboratory activities in the time table.
25. In foreign countries there are no separate mathematics laboratories, simply because every classroom is itself a mathematics laboratory since in these countries the teachers themselves examine their students and they ask their students to do mathematics practicals in the classroom and they give marks to the students for this work. Most of their textbooks have sections on enrichment and mathematics practical activities and so they do not need separate mathematics laboratories. In our case since we have external examinations and the teachers cannot ask students to do mathematics practicals in the classroom, we have to have separate mathematics laboratories.
26. It is desirable that every teacher should also do laboratory work with his or her own students, but till such time as all the teachers can be trained to do this work in the right spirit some teachers may be designated as mathematics laboratory teachers and a

separate room for a mathematics laboratory may be allotted. Students from different classes can go to this room in different periods and the laboratory incharge designs special experiments, for each class in consultation with the class teacher concerned.

27. Some schools have already included mathematics laboratory as a component of the socially useful productive work programme and many students prefer to take this component over others. Parents also like this because this activity strengthens the motivation of the students in learning mathematics and science.

28. In many schools, with mathematics laboratories, it has been found that even if the experiments are not directly related to the syllabus, the joy that the students get in preparing charts and models and the thrill and excitement that they get

in discovering new results themselves, enables the students to do much better in the normal classroom examinations. After all motivation for learning a subject is an important factor for learning the subject and mathematics laboratory activities provide a great motivation for learning mathematics.

29. The expenditure on a mathematics laboratory is less than the expenditure on a science laboratory and mathematics laboratories can also be used in learning other science subjects.

30. Mathematics laboratories should also aim to bring mathematics closer to other school subjects and experiments can be designed to show the applications of mathematics in physics, chemistry, biology, economics, commerce, history and other school subjects. Mathematics across the curriculum can become a reality through mathematics laboratories.

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Science Practicals Ignored

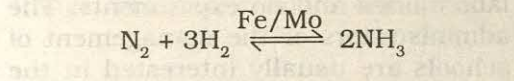
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Sometime back I was appointed by the State Board of School Education, as an examiner to conduct examination on Chemistry Practical for the students of Class XII of a reputed college. As per the instructions given for the paper setter, the tasks assigned for the examination included a single salt for analysis and a volumetric exercise consisting of an acid-base titration. Each student was expected to write the procedure for doing the salt analysis and the equation(s) of the chemical reaction(s) involved therein. After distributing the answer sheets, the students were explained what was expected of them. Once the instructions were over, every student took up the exercise on titration. To my utter surprise, none of them touched the salt. Their chemistry teacher was also present as an internal examiner and also to boost the morale of students. On my enquiry, the teacher told me that students normally avoid the analysis of salt. To encourage students to undertake analysis of salt, I even told them that they have the liberty to take the guidance of their teacher if they so desire, but this too did not cut much ice. At last, I told

Laboratory Assistant to put the salt samples back in respective bottles and advised students to disperse.

I was left to wonder as to which direction are we marching in a free country. When I look at the gadgets, like refrigerator, TV, VCR, in my house, which are also commonly found to all other houses, I wonder how scientists like Faraday, Marconi, Einstein and others might have worked day and night to discover basic principles of science that ultimately led to the development of these gadgets. All this has become possible because of the hard work done by innumerable number of devoted scientists, technologists and other workers in their laboratories. In order to accomplish their objectives these men of science often worked in very adverse conditions, even designing their own apparatus or sometimes working with improvised apparatus. But their concern for the development of science and technology with the ultimate objective of serving the society was unmatched. One may recall that during the Second World War, Germany fell short of petrol and the leaders of the nation asked the top scientists to evolve a technique to synthesize petroleum. A team of researcher workers namely Berguis, Fischer and Tropsch hydrogenated coal to accomplish this after trying many catalysts, different temperature and pressures. Similarly, scientists and technologists have developed a number of techniques to synthesize a large number of materials to meet the growing demand. At present, almost everything can be synthesized and made artificially,

such as, fibre, plastics, dyes and the like. Haber, another German scientist, synthesized NH_3 by reacting N_2 from the air and H_2 from water—



which is used to manufacture urea, and ammonium sulphate, one of the major components of fertilizers that paved the way for the green revolution in India.

Sum and substance of all this discussion is that greater emphasis should be laid on science practicals in schools not only to produce future scientists like Sir C.V. Raman, Dr. J.C. Bose, Dr. Khorana but also to provide well-trained human resource to carry forward and sustain the development of the country in all walks of life. Our students are future thinkers, discoverers, and inventors. To successfully accomplish this role, it is imperative that the students should not only master basic laboratory skills in school but also learn how to design simple experiments to investigate a given problem.

For developing the interest of students in science practical, a proactive role of parents, teachers, educationists as well as administrators is a must. Each one of them can do their bit to improve the dismal conditions prevailing in schools at present. All efforts need be made to convince the students about the importance of laboratory work and the need to develop scientific aptitude and interest in the study of science. Teachers and parents should make conscious effort to encourage their wards to be

curious, to raise questions and satisfy their quest for knowledge by answering their relevant queries or helping them to seek answers from different sources.

One of the most important aspects of science, in my opinion, is that it is a joint enterprise. The discoveries and inventions made by a scientist or a team of scientists at any point of time in any part of the world form the basis for discoveries and inventions elsewhere during the same period or subsequently. There are innumerable examples in the history of science to bring home this point. The parents and teachers can encourage students to discover for themselves this interdependence of scientific enterprise. For example, it is well known that Newton discovered the law of gravitation, when he saw an apple falling on the ground and not going up. He was guided to a great extent in his discovery by the work done by his predecessors like Galileo, Kepler, Copernicus and many others. Newton proposed the corpuscular theory of light and could explain reflection and refraction with it. His contemporary Hyghen proposed a wave theory for light and could explain successfully the phenomena of diffraction and interference. After Newton, wave theory of light found favour with the scientists until it was established that light has a dual nature; it behaves like a particle as well as a wave. Similarly, Einstein further refined the Newton's law of gravitation when he proposed his theory of relativity. John Dalton's idea that the atom is the smallest particle of matter was modified once the existence of

subatomic particles like electrons, protons and neutrons was established. These men of science could unfold the mysteries of nature because they could think differently and interpret the observations concerning a given phenomena in a way different than others. They then pursued their ideas further often through experimentation until they could establish them. Many a time they could not find evidences to support their ideas and had no hesitation in rejecting them. This, however, did not deter them in their pursuits because they were not afraid of accepting their mistakes.

In our schools, however, there is tendency amongst the science teachers to find one excuse or the other to avoid laboratory work or make demonstrations a part of their teaching in the class. One of the most common arguments given to justify their attitude is the lack of laboratory equipment and other resources available to them in schools.

Strangely enough, I know many a reputed public schools where students have never touched a chemical or performed any laboratory work in physics or biology. The laboratories in these schools are well equipped to conduct not only prescribed laboratory exercises but also for teacher demonstrations in the classrooms but unfortunately costly equipment and apparatus gather dust in the cupboards and in the long run get rusted. A majority of teachers do not demonstrate even the simplest experiments in the class because of the fear of failure in front of their students.

This pathetic attitude of many science teachers ruthlessly kills the enthusiasm and spirit of students most of whom are too eager to work in the laboratories and do experiments. The administrators or the management of schools are usually interested in the overall performance of their students in the Board examinations and often this objective is achieved by lavishly entertaining the examiners and taking good care of them.

I have no intention to paint a poor picture of teachers for their apparent disinterest in providing adequate opportunities to our students to acquire and master laboratory skills but I simply wish to highlight the long-term impact of these unhealthy practices on the development of the scientific attitude amongst our future generations. There is an urgent need to curb this menace as early as possible which requires a concerted effort from all those functionaries who are involved directly or indirectly with the education of our children in schools. I conclude with quotations from Leonardo da Vinci and Albert Einstein on the importance of experiments in the development of science.

"...those sciences are vain and full of errors which are not born from experiment, the mother of all certainty..." (Leonardo da Vinci, 1452-1519).

"Bear in mind that the wonderful things you learn in your schools are the work of many generations, produced by the many enthusiastic effort and infinite labour in every country of the world. All this is put in your hands as your

inheritance. In order that you may receive it, add to it and one day faithfully hand it on to your children. Thus, do we mortals achieve immortality in the permanent things, which we create in common.

If you always keep that in mind, you will find meaning in life and work and acquire the right attitude towards our nations and ages." (Albert Einstein).

Science News

Insat-3C Launched

INSAT-3C satellite, built by the Indian Space Research Organisation (ISRO), was successfully launched early morning on 24 January 2002, by the Ariane-4 launch vehicle of Arianespace. The 147th flight of Ariane, carrying ISRO's 2,750 kg INSAT-3C, lifted off at 05:17 am IST from Kourou, French Guyana in South America. INSAT-3C was injected into a Geo-synchronous Transfer Orbit (GTO), 21 minutes after the lift-off, in a 3-axis stabilised mode, with a perigee of 570 km and an apogee of 35,920 km and an inclination of 4 deg. with respect to the equator. The satellite at that time was going round the earth with an orbital period of about 10.5 hours.

The INSAT Master Control Facility (MCF) at Hassan in Karnataka acquired the telemetry signal from INSAT-3C after nearly 30 minutes i.e. at 5:47 am IST. The initial health checks on the satellite confirmed that the performance of the satellite is normal. Issuing commands from the Master Control Facility (MCF) at Hassan carried out first operations on this satellite. The outermost panel of the stowed solar array on the south side of the satellite was oriented towards the sun to start generating the electrical power required by the satellite during its transfer orbit phase. Subsequently, the earth viewing face was oriented towards earth and calibration of the gyros on board the satellite were carried out.

INSAT-3C was being tracked, monitored and controlled from MCF, Hassan, during the initial phase of the Operations. MFC also utilised INMARSAT organisation's ground stations at Beijing (China), Fucino (Italy) and Lake Cowichan (Canada) in these operations. The satellite's orbit has to be precisely determined by continuous ranging from the participating Telemetry Tracking and Command (TTC) stations.

The maneuvers for orbit raising operations on INSAT-3C were carried out by firing the 440 newton liquid apogee motor on board in stages till the satellite attained its final geo-stationary orbit, about 36,000 km above the equator. The satellite had about 1.5 ton of propellant (Mono-Methyl Hydrazine — MMH and Mixed Oxides of Nitrogen — MON-3) for orbit raising operations as well as for station keeping and in-orbit attitude control. The on orbit fuel availability will enable maintaining the satellite for operational services for a period of 12 years.

Deployment of the two solar panels and the two antennas was carried out when the satellite reached its near geo-stationary orbit and the finally the satellite has been put in its final 3-axis stabilised mode. The payloads will be subsequently checked out before the commissioning of the satellite.

INSAT-3C will be co-located with INSAT-1D at 74 deg East longitude. Other INSAT satellite locations are: INSAT-2C and INSAT-2B at 93.5 deg East longitude, INSAT-2E and INSAT-3B at 83 deg East longitude, INSAT-2A at 48 deg East longitude and INSAT-2DT at 55 deg East longitude.

INSAT-3C carries 24 C-band transponders, six extended C-band transponders, two S-band transponders and a Mobile Satellite Service transponder operating in S-band up-link and C-band down link.

INSAT-3C has the main body in the shape of a cuboid of $2 \times 1.7 \times 2.8$ m. When the two solar panels are fully deployed in orbit, it will measure 15.5 m in length. The sun tracking solar panels generate 2.75 kW of power. Two 60 Ah Nickel-Hydrogen batteries support full payload operations even during eclipses. INSAT-3C, like all its predecessors in the INSAT series, is a 3-axis body-stabilised spacecraft using momentum/reaction wheels, earth sensors, sun sensors, inertial reference unit and magnetic torquers. It is equipped with unified bi-propellant thrusters. The satellite has to deployable antennas and three fixed antennas that carry out various transmit and receive functions.

INSAT-3C is the second satellite to be launched in the INSAT-3 series. The first satellite, INSAT-3B, was launched on 22 March 2000. INSAT-3C is expected to augment the present INSAT capacity for communication and broadcasting, besides providing continuity of the services of INSAT-2C when it reaches the end of mission life late this year.

With ISRO Satellite Centre (ISAC), Bangalore, as lead centre, INSAT-3C was realised with major contributions from Space Applications Centre (SAC), Ahmedabad, Liquid Propulsion Systems Centre (LPSC) at Valiamala and

Bangalore, Vikram Sarabhai Space Centre (VSSC) and ISRO Inertial Systems Unit (IISU), Thiruvananthapuram. Besides, several industries in both public and private sectors have contributed to the realisation of INSAT-3C. The MCF is responsible for initial and in-orbit operation of all geostationary satellites of ISRO.

Physics-based Model For Doctors Handling Heart Cases

Dr. Richard Clayton and his team of researchers from the University of Leeds, U.K. has developed a new computer simulation that allows doctors and physicists to model the faulty heart beats (arrhythmias) that can cause cardiac arrest, and run episodes of arrhythmia time and again, looking for the best way of treating it.

Speaking today at the Institute of Physics "Simulation and Modeling Applied to Medicine" conference in London, presents and demonstrates how his team's physics-based understanding of the heart could lead to improved treatment.

In presenting an overview of the project Dr. Clayton first explained how electric impulses behave in the functioning of a normal heart. According to him during a healthy heart beat, a wave of electrical activity sweeps through the heart muscle, moving from the inside towards the outer surface making the heart start to contract, before dying away. However, in the event of a cardiac arrest this normal pattern is disturbed. The electrical activity fails to die away properly, and moves around the muscle in a turbulent pattern causing

an arrhythmia known as ventricular fibrillation.

The detailed biophysical and anatomical model developed by the research team can simulate this activity and one can then test different pharmacological and physical treatments that could help the patient. The simulation requires massive computing power; even using high-speed equipment, it takes 24 hours to simulate one second of heart activity. The end result, however, is a sequence of colour images of the beating heart, showing the pattern of electrical activity and enabling researchers to visualize the effects of different therapies. At the same time, the model have the provision to simulate the electrical signals that would be detected by external monitoring devices and show how the particular state of the heart would appear in a clinical electrocardiogram trace. This allows their simulation system to provide information that will assist in day-to-day care of patients who are prone to ventricular fibrillation following a heart attack.

Cholesterol Breakthrough !

Here is good news for cream and butter lovers from a group of Israeli scientists who say that they can now eat their favourite fat containing foods without feeling guilty about rising cholesterol level in their body. According to the scientists this would be possible due to a chemical process developed by them that removes cholesterol from the body.

Professor Nissim Garti, a chemist at Jerusalem's Hebrew University, has

designed what he calls tiny "nano-vehicles" to deliver specific nutrients to the blood stream and inhibit the delivery of other molecules, such as cholesterol. According to Garti these vehicles can either be used to enhance transport of certain molecules or else to retard or to depress transport of other molecules. Garti's custom-made nano-vehicles transport phytosterols - plant fats believed to help combat cholesterol - to the blood stream instead of cholesterol.

Explaining their mode of functioning Garti said that the cholesterol is expelled through the digestive system and the body, which is incapable of utilizing them, discharges the phytosterols. The result is that after a few weeks of intake of these new vehicles, the levels of total cholesterol are reduced by 15 to 30 percent depending on the amount of daily intake. The so-called vehicles, which Garti designs for each individual compound are about 5 to 15 nanometres and are made out of water, oil, an emulsifier and alcohol.

Stem-Cell Cloning Holds Promise in Cancer Research

In the near future a team of scientists in the United Kingdom will make the first application for a government licence to carry out the cloning of human embryos.

Literally opening a Pandora's box of medical wonders, although not without important ethical implications, their objective will be to initially use space IVF (in-vitro fertilization) embryos and later clone early human ones as the main component of research on embryonic stem (ES) cells, the parents of all cell types.

This research will offer the means to repair damage caused by Alzheimer's and Parkinson's disease, stroke, spinal cord injuries, heart ailments and diabetes.

The Bio-industry Association of the UK has said that human trials of ES treatment could start within three years. But the team at Sheffield University, northern England, emphasized that they were not providing anything in the nature of a "quick fix".

Professor Peter Andrews of Sheffield University says that he finds it difficult to envisage routine use of the technology on other than selected volunteers in the next 10 years. He is the first UK scientist to work on human ES cell lines in culture. His work follows extensive research of a peculiar type of tumour called a teratoma. These contain a haphazard mixture of tissues, such as bone, nerve and muscle, as if from an embryo whose development became catastrophically scrambled.

Lessdramatic but highly malignant forms occur more commonly as testicular cancers in young men. Study of these cancers has led to the ability to grow ES cells as well as the prospect of their use as remarkable sources of tissue for transplantation therapy. The malignancy of testicular teratomas is mainly caused by a stem cell known as an embryonal carcinoma (EC) cell. During the 1970s, lines of EC cells from mouse teratomas were established in culture. It was soon shown that EC cells closely resemble ES cells, the forebears of all the different cell types that make up the developing embryo.

The way that both have the potential to turn into more specialized cell types — a process known as differentiation — was of particular interest to scientists interested in understanding how embryos develop. Indeed, it was through parallel studies of teratomas and embryos that scientists were eventually able to isolate ES cell lines directly from early mouse embryo.

Professor Andrews cautions that while many of the processes that control embryonic development are shared by mice and men, despite millions of years of separate evolution, some must be unique to humans. Therefore to understand better how human embryos develop and how the process can sometimes go awry, we must study human embryonic cell differentiation directly.

It was with this in mind that some 20 years ago, Professor Andrews and colleagues began to work with EC cells from human testicular teratomas, first at the Wistar Institute in Philadelphia, Unites States, and then at Sheffield University. One line that they studied, called NTera2, is particularly prone to differentiate into nerve cells, making it a useful tool for studying neurogenesis.

Scientists at the University of Pittsburgh are investigating whether or not transplanting neurons derived from EC cells into the brain can help alleviate the suffering of stroke patients. EC cells are cancer cells and there are concerns about whether their derivatives are truly "normal". This provided the basis of the recent excitement surrounding the successful derivation of human ES cell

lines from "excess" embryos that would be destroyed following IVF treatment for infertile couples.

These are clearly different from mouse ES cells, underlining the importance of being able to use human ES cells to investigate human development. Such embryos have been used for the past decade for strictly defined studies on infertility, congenital disease or miscarriages, contraception and screening embryos for genetic defects.

The Sheffield team is to apply to extend its studies. Early embryos, consisting of 100 or so cells, would be dismantled to obtain their stem cells to see how they could be used to create heart muscles, blood cells and nerve cells.

ES cells may also provide a variety of tissues for the transplant surgeon. Much has recently been heard about "adult" stem cells and what they might achieve, implying that use of ES cells could be avoided. But we still have very little understanding of these and it is far from clear whether or not they will be as useful as some recent reports have suggested.

Professor Andrews asserts that it is likely that ES cells and adult stem cells will provide complementary tools; it is far too early to decide upon their respective benefits. In his opinion cloning technology adds very little at this stage. Ultimately, researchers may indeed find this approach useful to match ES cells to their potential donor. However, there is still much to be done to assess just what ES cells can do, first.

Courtesy: Spectrum online

Physicists defy Weakest Link

The newly discovered superconducting material magnesium borate has properties that will have important implications for use as a conductor and a high field-generating device.

Work done at Cambridge University, UK, by Dr David Cardwell and his colleagues have revealed that the complex material which behaves like ceramics has equalities that overcome problems many superconductors have—it is not particularly sensitive to the application of a magnetic field. According to Dr Cardwell this is a major breakthrough in this field with exciting implications for potential applications as both a conductor and a high field-generating device.

Until the late 1980s, theory suggested that superconductors could not exist above minus 240 degrees celsius ($^{\circ}\text{C}$) (approximately 30 kelvin). But a generation of so-called high-temperature superconductors was discovered in 1987 that were developed to superconduct at minus 107°C (166 kelvin).

The higher the electrical currents that a superconductor can carry at a given temperature, the greater its potential for use in everyday life. Superconductors are used for a variety of applications including magnetic resonance imaging and energy storage devices that provide a steady power supply for underground and overland trains.

Many of the high-temperature superconductors have serious drawbacks.

The complex metal oxides are both granular and brittle. When made into wires or other useful materials, it becomes difficult to pass current from one grain to the next.

These grain boundaries are effectively the weak links to the flow of electricity, severely limiting the application potential of the materials. Borate reveals that grain boundaries do not form weak links to the flow of current. The material also overcomes another problems is so much as it appears insensitive to the application of a magnetic field.

Courtesy: Spectrum Online

Knocking Out Function of Respiratory Virus Genes

Millions of children lose their lives every year all over the world due to asthma and respiratory illness caused by respiratory syncytial virus (RSV).

The results of a research study have shown promise to knock out the function of specific RSV genes by the use of synthetic inhibitory double stranded RNA (siRNA). This technique is expected to be exceptionally useful in furthering understanding of RSV and related viruses. In addition, it could lead to the development of new treatments to combat such viruses. Most organisms use double stranded DNA to store their genetic information. However, some viruses use single or double stranded RNA instead.

Among those that use single stranded RNA are RSV and the viruses responsible for influenza, measles, mumps, rabies, lassa fever and ebola.

These organisms present unique challenges to researchers, as they cannot be studied using conventional genetic techniques, which are designed for DNA.

Vira Bitko and Sainen Barik from the University of Alabama, USA have used a technique called "post-translational gene silencing" whereby specific siRNA molecules are synthesised and used to target specific regions of the virus RNA. They have found that when siRNA was introduced into virus-infected cells, the production of specific viral proteins were blocked and replication of the virus could be efficiently suppressed. Furthermore, there was no detectable effect on the gene expression of the host cell, confirming that the technique is specific to the RNA virus. The researchers also showed that siRNA acts by a mechanism that does not involve the interferon response that is triggered by viral infections.

Gene Therapy Research in Dentistry

According to a follow-up report by researchers, a significant progress has been made in gene therapy research, including treatment for head and neck cancers and repair of damaged salivary glands.

Dr Baum, one of the co-authors of the report and the chief of Gene Therapy and Therapeutics Branch, National Institute of Dental and Craniofacial Research (NIDCR) at the National Institute of Health, USA asserts that noteworthy advances in gene therapy relevant to dentistry has occurred since

1995 when he has co-authored an article on the potential impact of gene therapy on dentistry by the year 2015. The significant advances that find a place in Dr Baum's list include such areas as treatment for head and neck cancers, repair of bony defects caused by periodontal disease, trauma or surgery, and therapy for salivary gland dysfunction. His review in 1995 addressed initial efforts in three areas of orally related gene transfer research while the new review addresses seven areas of relevant research, and for all seven, substantive proofs of concept have been shown in animal models.

According to Dr Baum, cancer-related gene therapy appears effective as an adjunctive therapy for head and neck cancers. He further asserted that although current gene transfer methods are still considered to be fairly primitive, and associated with significant problems, gene therapy's acceptance as part of the routine clinical armamentarium, at least for some applications (like head and neck cancers), seems very close. Advances in salivary gland research, including NIDCR studies in animal models, show repair of damaged salivary glands and therapeutic applications to systemic diseases are possible through gene transfer technology.

Although applications of DNA vaccination are in the earliest stages, researchers are optimistic that these approaches will play a role in future strategies for preventing periodontal diseases and dental caries (tooth decay). In spite of considerable problems it is felt that gene therapy will have a pervasive and significant impact on

areas of dentistry that are based in biological science and, by the year 2015, this will translate into dentists having a wide range of potential treatment options.

Plastic LEDs : A Breakthrough in Telecommunications with Widespread Applications in Fibre Optics Possible

In the past few years, polymers (plastics) that emit visible light have opened up exciting with the prospect of inexpensive and flexible products. However, the large optical telecommunications market seemed to remain outside the purview of these new light-emitting polymers because the plastics could not emit efficiently in the near-infrared (near IR) band where the optical fibres that carry the communications are most transparent.

Dr Nir Tessler and his team working at the Technion-Israel Institute of Technology in Haifa, together with Uri Banin and his team at Hebrew University in Jerusalem, has announced that they have been successful to get polymers that emit near-IR radiation. This has been accomplished by the researchers by incorporating tiny nanocrystals in the polymers. Once commercialized, such nanocrystal polymers could potentially cut the costs of the hundreds of millions of telecommunications terminals needed to bring fibre optic communications to individual homes, opening the family doors to global networks.

Polymer light-emitting diodes (LEDs) are much cheaper to make than conventional solid state LEDs and lasers. In the conventional devices,

materials are laid down in a vacuum and exposed to light through a patterned mask. Then part of the layer is removed by acid in a complex, multi-step process. But because polymers are soluble in various solvents (organic solvents, water, acetone), polymer layers can be sprayed onto materials with ink-jet printers, forming devices as the solvent evaporates in a much simpler and cheaper method. Visible light-emitting polymers already are being incorporated into products ranging from flat panel displays to infant mobiles.

Optical telecommunications, however, require near-IR radiation, for in this bandwidth optical fibres are almost entirely transparent. According to Dr Tessler, who was among the pioneers at Cambridge University in England, researchers believed that polymers could not efficiently produce near-IR radiation. This is so because the softness and flexibility (attractive features) of polymers are associated with vibrations (motion of atoms) on the molecular scale. These vibrations took off most of the energy of the radiation. As a result the polymers or polymer-erbium composites produce near-IR radiation at a very low efficiency — around 0.01 per cent — far below that needed for economical operation.

Dr Tessler's solution to this problem is to incorporate nanocrystals of solid semiconductors into the polymer. The polymer is used to create the necessary device structures and the nanocrystals act as near-IR emission centres. On top of that says Dr Tessler, the polymer conducts the electricity to the nano-

crystals, where the near-IR radiation is emitted. The nanocrystals are designed to have a shell of zinc selenium, which isolates a core of indium arsenide from the vibrations of the polymer, acting as a nano-scale shield (bumper). In this way, when the nanocrystals are made to emit near-IR radiation, the energy is not linked to the polymer vibrations and hundreds of times more radiation is produced. The Israeli team has demonstrated an efficiency of two to three per cent at a wavelength of 1.3 microns, within the range of interest in fiber optic tele-communications. Since the nanocrystals are dissolved within the polymer, the polymer-plus-nanocrystal solution can be ink-jet printed just as other polymers can.

The Technion and Hebrew University research groups now are developing different nanocrystal-polymer combinations to increase efficiency another ten-fold to the range of 20-30%. Researchers also expect to increase the wavelength to 1.5 microns, the best wavelength for telecommunications. Although further work is needed to produce the actual lasers for high speed fiber links, this new technology could pave the way for high-speed optical fibre links to every home.

Source: Stanford University (<http://www.stanford.edu/dept/news/>)

A New Method for DNA Detection

An innovative pairing of microelectrodes and probes of gold nanoparticle is at the heart of new technology that has been developed at Northwestern University,

USA. The new technique simplifies DNA detection and in the near future could lead to a handheld device that is more accurate, less expensive and faster than conventional methods. "Nanotechnology can be used to get better results in all categories that are important in DNA detection — sensitivity, selectivity, cost, ease of use and speed, according to Chad Mirkin, Director of Northwestern's Institute for Nanotechnology. Mirkin who led the research team asserts that the electrical DNA detection method invented by them excels in all of these areas and has a good chance to become a truly disruptive technology.

The team of scientists used a synthetic sequence of DNA that models the anthrax lethal factor to test a technology that could displace polymerase chain reaction (PCR) and conventional fluorescence probes in clinical diagnostics and make point-of-care DNA testing possible in any doctor's office or even on the battlefield. In this technique a simple electrical signal indicates that target DNA has been detected, and hundreds of pathogenic agents could be monitored simultaneously. The new DNA detection method is unique as it eliminates the expensive and currently necessary step of heating the gene chip and also improves upon optical detection methods suggested earlier groups working at Northwestern Institute.

Once optimized, the technology could be used to quickly and easily detect biological weapons such as anthrax and smallpox as well as a wide range of genetic and pathogenic

diseases, from genetic markers for cancer and neurodegenerative diseases to HIV and other sexually transmitted diseases. Results could be available in a matter of minutes instead of days.

The technology, which is yet to be fully optimized is 10 times more sensitive and 100,000 times more selective than conventional methods. It can pinpoint single-base mismatches that are missed by conventional fluorescence technology. This opens up opportunities in the rapidly growing area of single-nucleotide polymorphism (SNP) detection.

According to the researchers this system is based on conventional microelectrodes, tests could be produced for a fraction of what conventional technologies cost, also it takes a fraction of the time to process and interpret results. In contrast, the technique used currently, employs gene chips technology PCR coupled with fluorescence to do DNA testing. The gene chips are read using a confocal microscope, which is an expensive complex instrument. The whole process requires a long series of complicated steps.

Northwestern's electrical DNA detection method would eliminate the expense of PCR and fluorescence and allow testing for thousand of different biological targets on one chip. Using this method, various DNA tests can be placed on a glass slide, each test made up of single strands of synthesized DNA, or oligonucleotides, with a sequence designed to bind with its complementary target DNA. These "Capture" oligonucleotides are placed in between a pair of electrodes, one test for each pair. The

slide then is placed in solution containing the target. Perfect and partial matches alike bind to the oligonucleotides on the slide's surface. The gold nanoparticle probes, each covered with 200 oligonucleotide strands latch on to these pairings.

The probes are then amplified using modified photographic developing solution. Each gold nanoparticle becomes covered with silver and grows in size, closing the gap between the electrodes and carrying a current. The crucial next step is to eliminate the perfect match from a close match.

Temperature, or a thermal stringency wash, is the conventional tool for differentiating between the perfect and close match. With the new methods, this complicated step is eliminated. Instead, a change in the concentration of a salt solution can be used to break apart any mismatches. Only the perfect matches remain, allowing the silver-coated gold nanoprobe to carry a measurable electrical signal across the gap between electrodes.

The researchers made the important observation that these nanoparticle probes are very sensitive to changes in salt concentration, allowing them to replace the conventional thermal

stringency wash with a "salt stringency wash."

The researchers made the important observation that these nanoparticle probes are very sensitive to changes in salt concentration, allowing them to replace the conventional thermal stringency wash with a "salt stringency wash."

To illustrate the superiority of their method, the researchers took on the challenge of what is called the "G:T wobble," a single-based mismatch of DNA that is difficult for conventional methods to distinguish from the perfect match of the target DNA. Such difficulty in discrimination can lead to false positives. The Northwestern method was able to distinguish between the match of two perfectly complementary DNA strands and the near-perfect match where just one base pair was wrong. The conventional fluorescence method would be unable to effectively distinguish the two.

In addition to clinical diagnostics, other applications of the electrical DNA detection method include SNP analysis, the fabrication of high-density electrical gene chips, and portable field sensors for the defense of biological warfare and terrorism.

Book Review

Computales

Book Reviewed: *Computales*; **Author:** Homagni Chaudhari; **Publisher:** Indus (An imprint of Harper Collins Publishers India Pvt. Ltd.), 7/16, Ansari Road, Daryaganj, New Delhi-110002; pp. 86; Rs. 30.00

In the modern age, computers have indeed become indispensable. They have pervaded almost all parts of human activity and have become an integral part of man's everyday life. Examination results, telephone and electricity bills, railway reservation, bank statements etc. are all processed through computers. Computers are used even in watches, ovens, lifts etc.

Computers are electronic machines that perform calculations with incredible speed. Besides calculations, computers these days can also be used for creating graphics or even generating music. In fact, personal computers (PCs) have now become commonplace devices at homes, offices, banks and in schools.

However, it should not be forgotten that a computer has no brain of its own. It simply follows the instructions given to it in the form of programs, also called software. Therefore, given wrong information or data, the computer can be quite silly indeed. Technically, this is called GIGO; garbage in, garbage out.

Computer science now forms part of school curricula. Therefore, children have to work on computers not only in schools but at their homes also. However, some children become

computer addicts in the process. Included in the collection of stories under review on computers, is a story titled 'Susmycin' that deals with the theme. Doily gets so much addicted that she always loves to sit in front of the computer terminal with the keyboard on her lap. Besides doing sums using the computer language Basic She is also able to draw pictures and cartoons on the computer terminal and play music through the speaker of the computer. Thus, computer takes all her time. Poor Doily comes in clash with the motto of her family that there is a time to work, a time to play, and a time for physical activity. However, Susmita—popularly called Shoot-Auntie, comes to Doily's rescue by writing program named Susmycin. Capable of curing the 'compu-addicts' the program later becomes in great demand. Indeed, a delightful story to read and enjoy.

Then, there are other stories in the collection that make quite an interesting reading. The story titled 'The Runaway' is about a maths wizard Baboo who failing to score highest marks in mathematics in the class gets disgusted and decides to leave home for good. Along with Tobot, a child-care robot engaged to look after him, Baboo leaves the town in a truck. It is indeed delightful to read how Tobot succeeds in the final rescue act.

Overeaters may sometimes harass and spoil the mood of hosts. But a program named 'PARTY' may indeed come to the aid of such harassed hosts and prove a boon for them. Read on the story 'Hilsa' to find the answer how.

Remember the Y-2k problem that once plagued the computers the world over? Though computers are wonderful they work on the instructions given by the user. Sometimes, this may lead to silly situations also. For instance, in the story 'Late Fee', the library computer imposes an unbelievably heavy fine of Rs. 3,244.80 on Chumki for alleged late return of a book which actually has not even become overdue. Similarly, in the story 'Pishimoni and the Computer', 105-year old Annapoorna Debi, popularly called pishimoni, gets a form printed out by the village computer that demands to know 'why has she not been admitted to the village primary school' in spite of her having completed five years of age. A funny situation indeed but as the computer was programmed to recognise only the last two digits for age, it recognised only 05 instead of 105.

The appearance of virus in the hard disc may indeed plague a computer. The virus may enter into the hard disc through infected floppies. In fact, a virus is a small program, written by nasty people for their silly fun, to spoil the information on the hard disc. The problem posed by the virus is beautifully brought home in the story 'The Virus'.

The collection of stories under review has also a futuristic story, 'Freebird'. It

centres round the concept of automation. 'Freebird' has its autonomous functions controlled by a sixty-four-bit microprocessor with thousands of nano processor chips controlling the individual functions. The expert software system HomAdmn is responsible for the coordination and overall administration. In short, the story is about a smart mobile home. But, one day shortage of a simple item like sugar puts HomAdmn into a fix. The story brings home the point that automation may not always prove blissful.

All the stories in the collection have been written in simple language and in an easy-to-follow style. Some technical terms followed in computer jargon like hard disc, floppy, virus etc. have been explained in the stories without taking recourse to technical language. All the stories are well illustrated with nice and delightful sketches. Leafing through the pages of the collection, children can indeed spend jolly good time. Certainly, the book will be able to make stories about computers popular among young readers.

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FORM IV
(See Rule 8)

SCHOOL SCIENCE

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I, Puran Chand, hereby declare that the particulars given above are true to the best of my knowledge and belief.

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A paper chromatograph of chlorophyll



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